Interaction Between Groundwater and Surface Water Regimes and Mining-Induced Acid Mine Drainage in the Stockett-Sand Coulee Coal Field

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# TECHNICAL COMPLETION REPORT

Interaction Between Groundwater and Surface Water Regimes and Mining-Induced Acid Mine Drainage in the Stockett-Sand Coulee Coal Field

Project A-129MONT

to

Montana Joint Water Resources Research Center Montana State University Bozeman, Montana 59715

and

Montana Department of State Lands Helena, Montana

bу

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#### **ABSTRACT**

Abandoned underground coal mines in the Stockett and Sand Coulee, Montana region have been discharging acid water for many years, causing severe pollution of Sand Coulee Creek and tributaries, and ground-water resources. A two-year investigation of the hydrogeology of the Sand Coulee Creek basin was conducted to formulate acid mine drainage mitigation techniques base on hydrologic systems controls and de-centralized neutralization.

Periodic field inventories in 1980-83 located at least 17 acid discharge points flowing either perennially or ephemerally. The measured total rate of acid discharge ranged from 1-3.3 ft<sup>3</sup>/s. Most acid discharges were of very poor quality with field pH ranging from 2.2 to 5.4, acidity from 108 to 6002 mg/l as CaCo<sub>3</sub> and specific conductance from 1038 to 15,966 microsiemens per centimeter. Water types were mostly ferrous-alluminum sulfate with dissolved iron concentrations from 12 to 1065 mg/l.

Two stream gaging stations were installed on Sand Coulee Creek and one on Straight Creek. Although the watershed area of Straight Creek is only 4% that of Sand Coulee Creek, it had longer duration and sometimes greater magnitude baseflow, primarily composed of acid mine drainage. Acid water comprises roughly 60-90 % of the baseflow of Sand Coulee Creek. Most baseflow is lost to evapotranspiration and subsurface seepage.

A regional inventory of 46 domestic wells indicated that approximately one-half utilized the Madison Limestone aquifer as the primary water source with most of the remainder equally divided between Kooten-

ai sandstone and Jurassic sandstone aquifers. Most alluvial ground water is polluted and has not been utilized by residents for many years. Vertical ground-water gradients are primarily downward which has allowed mine drainage contamination to reach the Jurassic and Madison aquifers. Water quality analyses and chemical modeling indicated the probable contamination of seven of sixteen sampled wells in these aquifers. Mine drainage water reaches lower bedrock aquifers through stream seepage, alluvial ground-water leakage and well bore leakage.

Proposed mitigation techniques included, infiltration control through cultivation of water consumptive crops and grain re-cropping in recharge areas, vertical connector wells or horizontal wells to dewater the Kootenai aquifer overlying the old coal mines, injection and neutralization of acid water in the Madison limestone and small-scale neutralization pits using flyash and alkaline Kootenai ground water.

Key words: Acid mine drainage, streamflow seepage, surface waterground-water interaction, ground-water contamination, infiltration control, drainage wells.

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#### 1. INTRODUCTION

This report presents results of the Montana Water Resources

Research Center project no. A-129MONT, Interaction between ground water
and surface water regimes and mining-induced acid mine drainage (AMD)
in the Stockett-Sand Coulee Coal Field. The second year of the project
was 50% funded by the Montana Department of State Lands, Helena, Montana. The project was conducted by the Montana Bureau of Mines and
Geology, Butte, Montana in 1981-83.

### 1.1 Problem Description

Coal in the Stockett-Sand Coulee area, near Great Falls, Montana, occurs within the upper part of the Morrison Formation (Jurassic) and is exposed along outcrops in the valley of Sand Coulee Creek and its tributaries. Unlike the Eastern Montana Tertiary coal deposits, the coal in this area is higher in grade (bituminous) as well as in sulfur content (0.5-5.5%) and is moderately high in ash (about 20%) (Silverman and Harris, 1967). Mining in the area commenced before the turn of the century via numerous adits which were constructed along the bottoms and sides of the major coulees. The last large-scale mine closed in 1952, but some recent exploratory drilling has been concentrated in the area between Great Falls and Stanford, where these coal deposits occur generally within 100-300 feet of land surface.

The extensive underground mining activity has allowed easy access for oxygen and water to enter the system of abandoned mines, and as a result, the area now has an extensive acid mine drainage problem.

Ground water infiltrates through the overlying Kootenai Formation into the Morrison Formation, oxidizing pyrite within the abandoned mines and

discharging at low pH (2.3-5.0) from abandoned mine portals or through mine spoil backfill materials.

While the existing problem is primarily the result of mining activities, it is possibly being enhanced by non-water conservative summer-fallow cropping practices on the upland benches, which increase the amount of water that moves into the subsoil and then into the Kootenai Formation. Any future mining operations which become active in this area will have to confront the hydrologic impacts of their activities during and after mining. In light of the proposed construction of coal-fired generating facilities in the Great Falls area within 20 miles of this old mining district, the probability of new mines being established somewhere in the Great Falls-Lewistown coalfield, although remote, is as great as it has been in the last 30 years. A location map is shown in Figure 1.

#### 1.2 Previous Work

Fisher (1909) published the first report on this area, describing the geology and coal resources in some detail and including a brief description of the mining operations active at that time. A chemical analysis of spring water near Stockett was made, which indicated that the water was alkaline and unpolluted.

Goers (1964) performed a geological study of the Stockett-Smith River area, which included field inventory of a number of water wells in this area.

Silverman and Harris (1967) described the geology and stratigraphy of the Great Falls-Lewistown Cretaceous coal field. A generalized stratigraphy and detailed isopachs of coal sequence were presented.

Also, geochemical characterization of a limited number of coal samples was performed.

McArthur (1970) performed a detailed short-term study of the environmental aspects of acid mine drainage in the Stockett-Sand Coulee area. He performed a detailed spring inventory and measured flows and pH over an eight month period for selected springs and surface-water stations. His work included an assessment of the hydrologic system, some water quality analyses and presentation of some alternatives for mine water neutralization, including limestone or lime treatment and mine flooding.

Hydrometrics (1982) submitted an extensive and comprehensive report on abandoned mine lands in the Belt-Sand Coulee area, concentrating on, but not limited to, the hydrology of acid mine water in this area. They provided a complete literature review, an assessment of amelioration alternatives and a re-inventory of the springs in this area. Some hydrologic data was collected, although only over a four month period.

# 1.3 Study Rationale

This project was designed to collect sufficient data to allow assessment of alternatives to centralized treatment of acid mine drainage. An ideal alternative to treatment would dispose of and/or prevent acid mine discharge in an inexpensive manner, easily applied over an extensive area, with reasonable maintenance. This investigation focused on the hydrogeologic background of two general amelioration techniques which may meet these criteria:

- Infiltration control; whereby the amount of water infiltrating the old mine workings is reduced by minimizing ground-water recharge or dewatering the overlying aquifer; and
- 2) On-site neutralization methods involving surface neutralization of the numerous small acid seeps in small ponds or by gravity injection and neutralization of acid water within the underlying limestone of the Madison group rocks.

# 1.4 Project Objectives

Project objectives for the first year of study (FY 81) were as follows:

- Initiation of a comprehensive inventory of all springs and water wells in the study area, including a re-inventory of springs recorded by McArthur (1970);
- 2) Establishment of 1-3 permanent stream gaging stations in the Sand Coulee drainage, including Straight (No-Name) Creek;
- Initial monitoring of springs in the area for flow, pH and specific conductance;
- 4) Water quality analysis, to characterize ground- and surfacewater quality and to support investigation of their interaction.

Project objectives in the second year included:

- 1) Continuation of acid discharge monitoring;
- 2) Streamflow monitoring via the gaging stations and seepage runs;
- 3) Completion of a comprehensive domestic well inventory, aquifer identification, static water levels and field water quality characteristics;

- 4) Collection and analyses of ground-water quality data;
- 5) Preparation of a proposal for implementation of AMD mitigation techniques using hydrologic systems controls.

# 1.5 Study Site Reference System

All springs and streamflow stations were numbered using an arbitrary sequential reference system, organized by drainage basin.

Acid discharge reference codes used in this and previous investigations are shown in Table 1.

Straight Creek, as it is called by local residents, is not named as such on the U.S. Geological Survey (USGS) quadrangle map, but refers to the drainage through the town of Sand Coulee that is tributary to Sand Coulee Creek. This drainage is referred to by McArthur (1970) as "No-Name Creek".

Hereafter, the term "study area" is used to refer to the drainage area of Sand Coulee Creek from its headwaters to a point about two miles north of Tracy, Montana, where the creek enters the abandoned Missouri River channel. The principal towns of the study area are from north to south, Tracy, Sand Coulee, Centerville and Stockett, shown in Figure 1.

# RESULTS

#### 2.1 Springs

#### 2.1.1 Spring Inventory and Monitoring

During the first year of the project, 17 springs were found to be discharging acid water from mine portals or spoil piles either perennially or intermittently (Figure 2). Nine springs flowed perennially,

while eight flowed only during or after spring precipitation and snowmelt periods. These springs in general corresponded to those observed by McArthur (1970) to be active in 1969. Five springs which flowed in 1969 (McArthur's 36-3, 36-6, 7-8, 7-9 and 18-5) were not observed to flow in 1980-81. Another seep in a spoil pile (13-2) found by McArthur has apparently become plugged in recent years. A large seep area near the old Giffen mine was not included in MacArthur's inventory, possibly because the pH is not below 4 at all times of the year.

Table 2 describes the active springs; ranges of flow, conductance and pH.

These springs were monitored on a periodic basis, to evaluate annual variability in flow and water quality. The results are included in Appendix A. During the period from 6-1-80 through December 1981, results for the monitoring may not be representative of the average year. The winters of both 1979-80 and 1980-81 were very dry in the study area, despite ensuing wet spring seasons. However, the patterns of variability and response of the acid springs to precipitation events are probably typical. The net discharges of acid mine water for this two-year period may be slightly below the long-term average.

Based on the monitoring to date, the acid springs can, with several exceptions, be separated into two arbitrary groups. The first group consists of springs with high flow variability (those which have a ratio of high flow to low flow greater than 5 and very rapid response to major springtime precipitation or snowmelt events, usually responding within a few days). These springs are usually associated with mine adits located less than 150 vertical feet below the top of the overlying bench. The second group also exhibits springtime increases in

flow but to a much lesser degree. These adits are located a greater vertical distance from the adjacent uplands where the ground-water flow system is recharged.

Springs in the first group (variable discharge) are in all cases located north of the town of Stockett, including the springs near the towns of Sand Coulee and Centerville. Some of these springs with exceptionally high variability include AS-01 (from 43-500 gallons per minute (gpm)), AS-07 (from 12.5-250 gpm) and CS-10 (from 0-80 gpm). In May 1981, peak flows at springs were obtained within two weeks of the end of the period of most intense precipitation. The pH in springs of the first group ranges from 2.29-4.20, with most in the range 2.3-2.9. Most springs (AS-03, AS-02, AS-04, AS-01, AS-07) tend to become only slightly more alkaline during high flow periods in the spring, probably due to dilution by alkaline recharge. Others (AS-06, CS-10) become more acid, probably due to flushing of pockets of stagnant water of high acidity from the mines due to an increased flow caused by infiltration on the upland benches. Recharge water infiltrating into the mines must not be of sufficiently high alkalinity or volume to reduce the acidity of the discharge.

Figure 3 shows spring discharge measured on 5/28/81, immediately after intense spring rains. The flows are, in all cases, the highest observed for each acid spring during 1980-1981 and in some cases represented an order of magnitude increase over discharge at low flow. Actively discharging acid springs are common along the west side of the upland bench separating Straight Creek from Sand Coulee Creek and are east of this bench relatively scarce in the Centerville area. This suggests that the springs in the town of Sand Coulee are locally re-

charged and that ground water flows in these mines to the northwest, possibly conforming to the dip of the Morrison and Kootenai beds beneath this bench. The total measured acid discharge from all springs was a minimum of about 358 gpm  $(0.8 \text{ ft}^3/\text{s})$  on 3-5-81 and a maximum of about 1479 gpm  $(3.3 \text{ ft}^3/\text{s})$  on 5-28-81.

Specific conductance (S.C.) values of mine discharge (Figure 4), taken at the same date, are in most cases not greatly lower than at other times of the year and in several springs is actually higher than at low flow. S.C. ranges from 476-10,306 microsiemens per centimeter (us/cm), with the springs discharging water of less than 1000 us/cm being either alkaline or dominated by alkaline recharge. Most spring discharges are in the range from 2000-7000 us/cm. Dissolved ferrous iron concentrations and concentrations of suspended ferric hydroxide have a large influence on the S.C. of these waters, and for this reason S.C. is probably less indicative of other water quality characteristics than it is for most natural waters. Spatial patterns are not apparent in this S.C. data, but generally springs which emit from backfilled minespoil materials are of poorer water quality and higher conductance than those discharging from open adits.

Specific conductance variations indicate that, despite the large increases in flow in the spring, very little dilution by recharge water is taking place. Most conductance values decreased by less than 25% in May 1981, in response to over 6 inches (in.) of local precipitation. Several springs (AS-06, AS-07) actually increased in conductance, suggesting again that isolated pockets of poor quality water in the mines are being flushed in the spring and lie stagnant during much of the rest of the year.

The very rapid hydrologic response of most acid springs suggests substantial interconnection between the surface and the mine workings, probably along vertical joints and fractures sometimes visible along valley walls. The morphology of stream and coulee orientations in the region suggests structural control which may be another expression of this joint system.

Several open adits were found in the bottom of Mining Coulee, south of Sand Coulee, where high water marks indicated that large volumes of surface runoff pour directly into the old mine workings. The rapid response of AS-Ol, in particular, may be related to this apparent surface water infusion.

From well records, saturated sandstone strata occur throughout the Kootenai Formation although only the basal sandstone unit shows extensive continuity and saturation. Recharge along fractures may increase the pressure head within these beds and augment the rate of leakage from these perched aquifers through fractures into the underlying basal Kootenai. The conglomeratic sandstone unit at the base of the Kootenai probably forms the roof of many of the mine adits and is the primary source of ground-water leakage into the old workings.

Increase of seepage rates from the basal Kootenai into the mines increases ponding of water within the mines and flushes pools of acid mineralized water towards the portals. Due to the slope of the adits, they drain freely and oxygen has ready access, allowing pyrite oxidation to occur at a high rate.

The recharge-discharge relationship for most acid springs is believed to be quite local. For example if the mean annual flow rate from ASO1, ASO2, ASO3 and ASO7 is estimated to equal 300 gpm (0.668)

cubic feet per second ( $\mathrm{ft}^3/\mathrm{s}$ )), assuming the approximately 3 square miles ( $\mathrm{mi}^2$ ) bench area south of Sand Coulee to be the recharge area, the annual recharge rate would equal 3 in. This represents about 19% of the mean annual precipitation, a reasonable estimate for this area.

Only a few springs fall into the second, low-variability category. They include CS-09, along Cottonwood Coulee two miles south of Stockett, and BS-01, the Giffen Mine East outflow. Both occur at elevations nearly 200 feet below the surrounding upland benches where ground water is recharged. This additional separation from recharge apparently dampens the spring response to rainfall and snowmelt infiltration. The Giffen Spring increased in flow by a factor of about 1.5 in May 1981; its water quality decreased considerably, with pH decreasing more than a whole unit and conductance increasing from 6000 to 8600. During fall and winter, at low flow, both pH and water quality improve somewhat.

The Giffen Spring (BS-01) produces relatively consistent baseflow, averaging 250 gpm (3040 acre-feet/year) during the 1981 water year. Local precipitation was probably slightly higher than the local average of 15 in./year, although no accurate precipitation data are available from this specific locality. Assuming 16 in. total for the year and assuming, quite liberally, that 50% (8 in.) of this precipitation contributed to ground water as infiltration rather than contributing to crop use, runoff, or evapotranspiration, then discharge from these mine workings was recharged from an area at least as big as 7.12 mi.<sup>2</sup>, an area greater than the 3-4 mi.<sup>2</sup> available for recharge along the upland bench immediately to the east of the mine. It is probable that groundwater flow in the Kootenai moving down gradient from its recharge area towards the Belt Mountain foothills is being intercepted by the old

mine workings and discharging from the north-westerly sloping Giffin adit.

# 2.1.2 Spring Water Quality

Water quality data collected from springs in 1980 and 1981 are listed in Appendix A (A-2). Field pH for spring waters ranges from 2.38-3.98 for all sites except BS-01, the Giffen mine, where it ranges from 3.8-5.4. While none of these springs are alkaline, acidity shows a broad range, from 108 (BS-01) to 6002 (AS-03) milligrams per liter (mg/L) as CaCO<sub>3</sub>. The waters are ferrous-aluminum-sulfate dominant, with minor calcium and magnesium. Iron (Fe) (12-1065 mg/L) and aluminum (A1) (1.72-752 mg/L) are the most abundant metals, although there are also high concentrations of trace metals including nickel (Ni) (0.24-5.31 mg/L) and zinc (Zn) (0.60-21.5 mg/L). Lesser (<1 mg/L) but detectable concentrations of cadmium (Cd), chromium (Cr), copper (Cu), and in some cases molybdenum (Mo) also occur. Both arsenic (As) (<80 parts per billion (ppb)) and selenium (Se) (<21 ppb) are at low concentrations.

expected to increase and possibly cause other sulfate species to attain saturation.

These waters are undersaturated with respect to all but a few mineral phases. One is gypsum; another is chalcedony, which becomes supersaturated in neutralized waters due to dissolution of silicates under acid conditions.

#### 2.2 Ground Water

Ground water occurs in most all of the permeable rock units in the Stockett-Sand Coulee area. A description of the geologic formations in the area is given in Appendix B. From oldest to youngest age, aquifers are known to yield water to wells from the Mission Canyon formation of the Madison Group (Mississippian), the Swift Sandstone (Jurassic), sandstone beds in the lower Kootenai formation (Lower Cretaceous), glacio-fluvial and glacio-lacustrine deposits (Quaternary) and stream alluvium (Quaternary). Figure 5 is a schematic hydrogeologic section. Vertically stacked aquifers separated by shale aquitards frequently occur, and surface water-ground water interaction is a common phenomenon. Ground water movement is primarily horizontal within specific aquifers, in response to the hydraulic gradient. Vertical movement of ground water can occur when two aquifers are in direct contact with each other, when natural rock fractures or man-made features such as well bores allow vertical movement, or by slow leakage through aquitards.

An inventory of domestic water wells in the study area was completed in summer 1982. Field data are presented in Appendix C (C-1) and included owner, location, static water level, field specific conductance and pH and water use information. Measured static water levels, and S.C.'s are shown in Table 4 and are referenced to a location map in Figure 6. Field data were correlated with the Montana Ground Water Appropriation forms which gave useful information on well completion, yield and the lithology encountered in drilling. A total of 46 domestic wells were inventoried on at least one occasion. The Madison limestone aquifer supplied 24 wells, Jurassic sandstones 11, Kootenai sandstones 10, and alluvium only 2. Five wells were completed in multiple aquifers and the water bearing source of two wells could not be estimated at all.

#### 2.2.1 Madison Aquifer

The Mission Canyon Formation of Mississippian Age is the principal aquifer in the Madison Group Rocks. It is composed of massive light-gray limestone and thin dolomite interbeds which have been extensively karstified. Ground water flows through fractures and solution cavities that may occur from near ground surface to depths of at least 700 feet. The aquifer appears unconfined to moderately confined in the study area based on water level data, and some Madison wells in the Centerville and Tracy area expel and suck air with considerable force. Horizontal ground-water flow is generally from south to north (Feltis, 1980, 2). Vertical ground-water flow in the study area is downward with some deeper Madison wells having lower static water levels than shallower ones.

The primary recharge area for the Madison aquifer is on the flanks of the Little Belt Mountains where many square miles of Madison Group rocks are exposed to relatively high precipitation (20 in. or more

annually). Additionally, streams are reported to lose water as they traverse portions of the Madison outcrop. More limited recharge occurs in the study area where local doming of the Madison results in exposures of fractured limestone in the Centerville-Stockett area. Streamflow from Number Five Coulee and Cottonwood Coulee directly infiltrates Madison rocks. The Madison also probably receives recharge as leakage from overlying saturated alluvium. Results of water quality analyses indicates that some of this recharge is acid mine drainage water.

The best known discharge point for the Madison aquifer is Giant Springs just east of the city of Great Falls. Approximately 300 ft<sup>3</sup>/s of ground water issues from large springs near and in the Missouri River (Patton, 1983). Between Tracy and Great Falls, the Madison aquifer may develop upward vertical leakage and discharge to overlying aquifers and to the pre-glacial Missouri River Channel south of Great Falls. Water quality and head data from the Madison, Swift and Kootenai aquifers is often similar, suggesting a high degree of interaquifer connectivity just north of the study area.

#### 2.2.2 Swift Aguifer

The Madison Group is unconformably overlain by Jurassic marine sediments of the Ellis Group. Sandstone of the Swift Formation directly overlays the Mission Canyon Formation in much of the study area. The Swift is a fine- to medium-grained, well-cemented quartz sandstone from 0-40 feet thick. It appears cross-bedded or massive in outcrop, weathering to a pale orange to brown color. Beds of chertpebble and brachiopod shell hash conglomerate may occur in the lower part. The Swift occurs over most of the study area and is well exposed

in the coulee bottoms of Cottonwood Creek north of Stockett and Number Five Coulee southwest of Stockett.

The Swift sandstone is known to yield water to three wells in the Tracy vicinity south of Stockett, and it is the probable source of two springs issuing near the bottom of Cottonwood Creek below the Morrison coal seam. Relatively little is known concerning the extent, thickness and water-yielding characteristics of the Swift sandstone between Stockett and Tracy. In the Sand Coulee Creek Valley north of Center-ville, water wells drilled to the Madison sometimes do not encounter the Swift sandstone, indicating it is probably removed by erosion. One Swift well just northwest of Tracy was sampled and has a TDS of 1,994 mg/l, indicating potential contamination from AMD in nearby Sand Coulee Creek. Data are too sparse to construct a potentiometric map of the Swift, although flow is believed to occur from south to north.

The recharge-discharge regime of the Swift aquifer is not well known. Like the Madison, it is probably recharged where exposed along the flanks of the Little Belt Mountains and to a lesser extent in the study area, where local doming and erosion in coulees bring the ground surface close to the elevation of the Swift Sandstone. Since there is no observable confining bed between the Swift and Madison aquifers, they may act as a unit north of Tracy where the Madison becomes fully saturated. Similar heads and water quality between Tracy and Great Falls further suggest the inter-connectivity of the Madison and Swift aquifers.

The Swift Formation is overlain by the Morrison Formation which consists of 100-200 feet of gray shale with interbedded sandstone, limestone and coal. The Morrison coal bed or beds occur near the top

of the Jurassic section and were the target of mining in the area.

# 2.2.3 Kootenai Aquifer

The Lower Cretaceous freshwater Kootenai Formation is present at land surface over most of the study area and unconformably overlays the Morrison Formation. The basal unit of the Kootenai is a resistant, cross-bedded, coarse, salt and pepper sandstone bed, from 2-80 feet thick (Walker, 1974). Above this basal sandstone, the Kootenai consists of numerous, lensaic, poorly continuous sandstone beds, 1-50 feet thick, interbedded with green, gray and maroon mudstone. The Kootenai is typically 100-300 feet thick in the study area with 100-300 feet of the upper Kootenai member having been removed by erosion. The basal conglomeratic sandstone unit directly overlays the Morrison coal bed and is a relatively continuous aquifer supplying wells throughout the study area. More discontinuous sandstone beds occur stratigraphically higher on the Kootenai and occasionally yield water to wells and springs.

Horizontal ground-water flow in the basal Kootenai aquifer is generally from the topographically high benchlands to nearby coulees bisecting the Kootenai formation. There is a regional bedrock dip of approximately 3-6 degrees to the north-northwest and ground water migrates down dip, commonly resulting in springs and seeps on the northwest terminus of benches. Southern and eastern Kootenai outcrops are usually drier. In unmined areas, natural springs are common at the contact of the basal Kootenai with the less permeable Morrison Formation.

The many thin sandstone and shale beds in the Kootenai are quite

brittle and flexure of the South Arch in Tertiary time resulted in extensive fracturing of the Kootenai rocks. These fractures and related joint systems readily allow vertical ground-water movement and recharge from surface sources. The limited data available from domestic wells indicates that the basal Kootenai aquifer is sometimes confined in the middle of benches, and is frequently unconfined in wells near the edge of benches where the Kootenai section is bisected.

In relation to acid mine drainage, the removal of the coal bed underlying the basal Kootenai sandstone aquifer has resulted in leakage of ground water into the old mine workings. The old tunnels and rooms are efficient ground-water drains, which locally dewater the basal Kootenai sandstone and allow water to be conveyed down-gradient to old mine portals situated at the outcrop areas in the principal coulees. The normally alkaline Kootenai ground water is exposed to atmospheric oxygen and pyrite in the old mines where the chemical oxidation process occurs, producing AMD.

# 2.2.4 Quaternary Aquifers

Ground water occurs in stream alluvium deposits of Sand Coulee Creek and tributaries in the study area. These deposits are relatively thin south of Sand Coulee and Centerville, typically 10 to 30 feet thick. North of these towns, the valleys of Sand Coulee Creek have been filled with a combination of alluvial, glacial, and lacustrine deposits to thicknesses of up to 150 feet as recorded by water well drillers. The alluvial deposits are typically sand and fine-medium size gravel, gravelly clay, sandy loam, and sandy clay, brown to yellow-brown in color.

Evidence of glacial and lacustrine deposits comes from the wide-spread influence of Pleistocene continental glaciation throughout the Great Falls area as described by Alden (1932) and Walker (1974). Several water well logs in the Tracy vicinity record alternating deposits of yellow, sandy clay and gray silt, consistent with a postulated sequence of glacial deposits and lacustrine deposits from ice-marginal glacial lakes.

Water wells in the abandoned pre-glacial Missouri River Valley north of the study area are reported to obtain good yields of ground water from scattered sand and gravel lenses (Walker, 1974). But the lateral occurrence and depth of these deposits are unpredictable. Wilke (1983) inventoried at least 5 water wells completed in Quaternary deposits found in the pre-glacial channel.

Although most of the alluvial deposits in the study area are saturated, little use is currently made of alluvial ground water due to AMD contamination. Only south of Stockett, above the highest elevation AMD source, is significant use made of alluvial ground water. The town of Stockett obtains a portion of its water supply from an alluvial infiltration gallery about 2 miles south of town. However, local residents report high iron problems occur in the spring when ephemeral AMD sources discharge upgradient from the collector.

The alluvial deposits of Sand Coulee Creek and tributaries are the intermediate receptor of most visible AMD in the study area. Stream channels cut into the alluvium carry most of the AMD discharge. However, in the Sand Coulee and Centerville vicinity, as the alluvial deposits deepen, streamflow is partially or entirely lost to the alluvium. AMD is therefore a continued source of recharge to the alluvium.

North of Tracy, the alluvium is apparently in direct contact with the Madison limestone. Reports from drillers indicate that the vertical gradient is downward, thereby allowing AMD contaminated alluvial ground water to recharge the Madison aquifer. Local residents also report that the acid alluvial ground water has caused failures of cement grout and steel casing in the alluvium and that downward leaking alluvial ground water has contaminated formerly good quality Madison aquifer ground water.

# 2.2.3 Ground Water Quality

The chemical quality of ground water in the Stockett-Sand Coulee area is quite variable due to the different types of rocks comprising the multiple aquifers, the effects of AMD, the hydraulic connections between aquifers and surface water-ground water interactions.

In general, it is possible to discuss each aquifer as having its own "characteristic" water quality and intra-aquifer trends. Variations from the typical condition are most often due to inter-aquifer mixing or to chemical reactions imparted by acid mine drainage water. Water quality data from laboratory analyses of sampled wells are presented in Appendix C (C-2).

#### 2.2.5.1 Madison Aquifer

Water wells tapping the Madison aquifer southeast of the Missouri River near Great Falls usually have total dissolved solids (TDS, calculated) concentrations usually in the range of 400-600 mg/l. Giant Springs, several miles northeast of Great Falls, is thought to be a regional discharge point for the Madison aquifer. The spring has been

sampled 11 times between 1890 and 1983 and has had a TDS of 369 to 498 mg/l and approximately equal milliequivalence of  ${\rm Ca}^{2+}$ ,  ${\rm Mg}^{2+}$ ,  ${\rm HCO}_3$ , and  ${\rm SO}_4^{2-}$  (Patton, 1983). Feltis (1980, 1) mapped TDS concentrations of Madison wells throughout northern Montana which showed a concentration gradient of less than 1000 mg/l near mountain uplifts to over 10,000 mg/l in the Williston basin. The density of wells sampled, however, except in the Great Falls and oil field areas, is quite low.

The chemical quality of Madison wells sampled in the Sand Coulee area is quite variable and does not fit expected patterns. Figure 7 is a histogram indicating that seven of twelve Madison samples were less than 600 mg/l, and five ranged from 600 to 2,413 mg/l. The five high TDS samples had milliequivalent ratios of sulfate to bicarbonate of from 1.7 to 7.7. Figure 8 is a Piper plot which graphically illustrates the progression of increased sulfate concentrations among the samples. An analysis of Giants Springs is included for comparison.

Since the high TDS wells are scattered throughout the study area, there is little evidence to support a water quality trend of this magnitude based on length of ground-water flow path. Anhydrite beds known to occur in the Charles Formation which, in places, overlies the Mission Canyon Formation, could be a source of sulfate and TDS increases. However, the Charles Formation is not known to occur in this area and lithologic logs of water-well drillers have not indicated any evaporitic zones in the study area.

Although natural sources cannot entirely be ruled out, at this time a plausible explanation for the anamalously high TDS and sulfate concentrations is the infiltration and mixing of AMD water with native Madison aquifer ground water. Higher TDS and sulfate concentrations

are a byproduct of the acid producing metal oxidation reactions that take place in the old mines and during surface water or ground-water transport of AMD. It is believed that the contaminated Madison wells are generally down-gradient from an AMD source, particularly if the well is in a tributary coulee bottom. The downward gradient and possible fractures associated with the coulee may provide the conditions favorable for contamination. Figure C-3 (Appendix C) shows the proximity of AMD sources to the Madison aquifer wells in the study area. Chemical models of the AMD and Madison ground-water interaction are presented in section 3.3.

#### 2.2.5.2 Jurassic Aquifers

The Swift Formation is the most prevalent Jurassic aquifer in the study area, however, other water-bearing sandstones occur regionally in the Morrison Formation which overlies the Swift sandstone. Four Jurassic aquifer samples were collected in this investigation but lack of well log information prevented differentiating the specific water-bearing zones.

Three of the Jurassic aquifer samples are calcium-magnesiumbicarbonate types with TDS of 277 to 433 mg/l, and one, the Lyman well, is a calcium-magnesium-sulfate type, with a TDS of 1737 mg/l. The analyses are plotted on a Piper diagram in Figure 9.

Wilke (1983) reported analyses from three Morrison wells and two Swift wells in the Great Falls vicinity. Morrison wells had TDS (sum of constituents) range of 908-1480 mg/l and had mixed water types. The Swift wells had TDS values of 846 and 1020 mg/l and were calcium-sulfate and sodium-sulfate water types respectively.

The proximity and hydraulic connectivity of Swift and Morrison aquifers to each other and to adjacent aquifers may give reason to expect water quality variability. The Lyman well appears anamolously high in TDS and sulfate and may be affected by AMD water. No log exists for the well but it is drilled on the very edge of the Sand Coulee Creek Valley which is known to be a source of AMD leakage to lower bedrock aguifers.

# 2.2.5.3 Kootenai Aquifer

The Kootenai aquifer is the surficial bedrock aquifer over most of the study area and receives recharge directly from precipitation and surface sources. Four water samples from the Kootenai aquifer were collected in this investigation.

Three samples were collected from the basal Kootenai sandstone aquifer, two from wells and one from a spring. The two well samples had TDS values of 369 and 433 mg/l and were a magnesium-bicarbonate type. The spring was located about 400 meters north of the Giffen mine works and had a TDS of 295 mg/l, and was a calcium-magnesium-bicarbonate type.

One sample came from a well also near the Giffen mine but located on the bench. The water-bearing zone was a limey sandstone about 65 feet below ground surface and about 50 feet above the basal Kootenai sandstone. The TDS was 369 mg/l and it was a calcium-magnesium-bicar-bonate type. The analyses are plotted along with the Jurassic well samples on a Piper diagram in Figure 9.

These results are similar to those of Wilke (1983) who sampled five Kootenai wells in the Great Falls vicinity and reported a TDS

range of 558 to 1,550 mg/l, with magnesium and bicarbonate being the principal constituents in three of the samples.

Total field alkalinity in the Kootenai samples ranged from 269 to 433 mg/l as CaCO<sub>3</sub> and field pH ranged from 6.63 to 7.48. Kootenai aquifer ground water is thought to be the principal source of leakage into old mine workings and hence is the water that becomes acidized. These analyses indicate that native Kootenai ground water is alkaline and of relatively good quality. The undisturbed Morrison coal bed is thought to be an aquitard and hence does not transmit appreciable quantities of ground water.

#### 2.2.5.4 Quaternary Aquifers

The alluvial valleys of Sand Coulee Creek and tributaries contain ground water, although in most of the study area, it is not used domestically because of AMD contamination. Residents long ago abandoned alluvial wells and consequently there are very few existing alluvial wells. No alluvial wells could be found north of Stockett, and so no data could be collected on alluvial water quality.

The town of Stockett's alluvial collector well 2.5 miles south of Stockett was field checked in spring, 1981 and found to have a pH of 5.3. The alluvium there is up-gradient from most perennial AMD discharges, however, ephemeral AMD sources apparently discharge during wet weather, causing some seasonal contamination. Stockett residents complained of iron staining and bad taste during these occasions and in 1981 drilled a deep well to the Madison aquifer for a public supply. This has been the trend throughout the study area. Shallow alluvial wells have been replaced by deeper bedrock wells to escape AMD contam-

ination problems. However, as previously indicated, both Jurassic and Madison aquifers show evidence of contamination in selected wells.

Further suggestion of alluvial ground-water contamination came from rancher O. G. Johnson who lives about 2 miles north of Tracy. He reports that a number of shallow wells drilled across his property in Section 31 (T. 20 N., R. 5 E.) and Section 6 (T. 19 N., R. 5 E.) encountered only AMD affected water. As a result, they drilled deeper wells to the Madison aquifer but in at least one case, acid water disintegrated the cement grout and steel casing causing the well to be contaminated and abandoned.

Contamination of alluvial ground water may extend along the entire reach of the pre-glacial Missouri River, now occupied by Sand Coulee Creek. The extent of contamination will be mapped in a subsequent investigation by the MBMG and Montana Department of State Lands.

#### 2.3 SURFACE WATER

#### 2.3.1 Gaging Stations

Three gaging stations were installed within the Sand Coulee drainage in Fall, 1980. The three locations (Appendix D) are Sand Coulee Creek at Centerville, below the confluence with Cottonwood Creek (CF-03); Sand Coulee Creek at Tracy, above the confluence with Straight Creek (CF-02); and Straight Creek north of the town of Sand Coulee (AF-01). The stations were installed with modified 90 degree V-notch weir plates, having a 30 degree cutout at the base to a gage height of 1.12 feet. The 30 degree modification was designed to increase the resolution of low-flow determinations, up to a discharge of about 1 cfs.

Stevens Type A recorders were employed in the stilling wells. The Centerville weir accommodated flows up to 50 ft $^3$ /s (gage height 4.24 ft), while the Tracy and Straight Creek weirs could measure up to 13.4 ft $^3$ /s (gage height 2.83 ft). Design plans and rating equations used for the weirs are included in Appendix D (D-1).

Daily discharge data and stream hydrographs for the gaging stations are displayed in Appendix D (D-7). The short term data allow only tentative generalizations to be drawn, including:

1) Sand Coulee Creek shows high annual variability in discharge. During late winter and spring, its flow is dominated by runoff from snowmelt and spring rainstorms in the Sand Coulee area and in the upper reaches of the watershed in the Belt Mountains. In 1981, intense spring rainstorms in May caused flash flooding along Sand Coulee Creek in the Tracy-Centerville area, washing away the two original stilling well installations at CF-02 and CF-03. Peak flows fell gradually, and by October the main watercourse was essentially dry. It would not be unusual for Sand Coulee Creek to be dry by August in a year of "normal" precipitation and earlier in dry years. Bank and bed materials around these two stations were washed out a second time in May, 1982, again following a spell of very wet weather. The instability of the channel materials and limitations on station construction forced the abandonment of the sites. They could be reinstalled as open channel stations. Peak flows topped the weirs by over one foot (gage heights >5.0 feet).

Low flow periods exhibited both streamflow losses and gains between the Centerville and Tracy weirs. Concurrent streamflow records in November, 1981 indicated a possible loss of 5-15 gpm in that reach. An eleven day period in latter August, 1981 indicated very little change in flows at about 300 gpm.

2) Straight Creek, despite having a watershed area of only about 4 percent the size of Sand Coulee Creek, has baseflows similar in magnitude and sometimes of longer duration. Sand Coulee Creek was dry from November through March in water year 1981, while Straight Creek had base flows of 0-10 gpm. The AMD from the many abandoned mines tributary to Straight Creek is primarily responsible. During low flows most of the water in Straight Creek infiltrates to the alluvium before the confluence with Sand Coulee Creek.

Peak flow in 1981 occurred on May 16 and reached 21.6 ft $^3/s$ . Summer flows generally ranged from 5.0 to 0.2 ft $^3/s$ .

#### 2.3.2 Seepage Profiles

A seepage profile can be viewed as an instantaneous detailed summary of variations in stream discharge throughout a watershed, although in practice the collection of this data takes as long as several days. In a stream like Sand Coulee Creek dominated by acid mine drainage, changes in water quality (pH, specific conductance, metal concentrations) also reflect variations in stream discharge and can point out stream gains or losses.

Acid mine drainage discharges into surface water systems and undergoes changes in both quality and quantity early in its downstream flow. Changes in surface-water quantity include losses, primarily streambed infiltration, and gains, primarly inflow from tributary drainages and seepage from shallow ground-water discharge. Changes in quality are primarily due to mixing with tributary streams and to precipitation reactions caused by oxidation of the acid water. Seepage profile data were collected to investigate these downstream changes in discharge and water quality and to relate them to the interaction of the ground water and surface water. All stream seepage profile sites are shown in Appendix D (D-2).

# 2.3.2.1 Number Five Coulee

The seepage profile on Number Five Coulee, conducted March 14, 1981 was terminated prematurely when a temporary restraining dam was breached. However, eleven measurements were made beforehand between the Giffen mine and the confluence with Cottonwood Creek. Streamflow measurements were made with a hand-held pressure-diaphragm current meter, readable to 0.1 ft/sec.

There were both gains and losses, but there appeared to be a tendency for decreasing streamflow possibly indicating losses to alluvium and bedrock. The net loss between successive measurements along the approximately four stream miles ranged from 24 to 104 gpm, and is depicted in Appendix D (D-3). The pH and specific conductance at the 11 sites remained relatively constant, with pH values from 6.05 to 6.68 and specific conductance values from 1159 to 1228 us/cm (see Appendix D (D-4 and D-5).

#### 2.3.2.2 Sand Coulee-Cottonwood Creek

Seepage characteristics of Sand Coulee and Cottonwood Creeks were determined with 21 seepage run stations established from 8-26-81, 1500 hrs., to 8-29-81, 1000 hrs. (see Appendix D). These included tributary flows entering at DFO1 (Sand Coulee Creek), BFO1 (Number Five Creek), and AFO1 (Straight Creek), as well as 18 temporary stations installed along the main drainage of the area formed by Cottonwood and Sand Coulee Creeks (CF01-CF18). The three permanent gaging stations were included in the seepage profile. Discharge was measured at each station except these three using a portable reinforced plywood 90-degree V-notch weir, graduated in hundredths of a foot. At each station the weir was installed and leveled across the channel using clay and mud. The water level was allowed to rise to equilibrium behind the weir, at which time the gage height was noted. At stations where the stream gradient was high, equilibrium was achieved within a few minutes; under gentler gradients, slow rise in water level persisted for up to four hours. At all stations except one (CF01), an equilibrium gage height was attained. The relative error of the technique is estimated at  $\frac{1}{2}$ 5

percent. The field pH and S.C. were measured at each station. In addition, seven water quality samples were collected and analyzed for major element chemistry and for both total recoverable and dissolved metals (Appendix D, D-6). The discharge at AFO1 had been sampled and analyzed six weeks earlier, on 7-17-81, and in light of the low variability of discharge, conductance and pH between these two dates, the data from this earlier analysis were considered representative of AFO1 during the seepage profile.

The results indicate that about 1078 gpm of surface water was input and about 1065 gpm was lost from Sand Coulee Creek as channel seepage and evapotranspiration between the uppermost point 5 miles south of Stockett and the mouth of the creek at the Missouri River.

Evapotranspirational losses in warm months complicate the interpretation of seepage profile data. Diurnal fluctuations of hydrographs from gaging stations on Sand Coulee Creek and Straight Creek indicate peak evapotranspirational withdrawals of 20 to 30 gpm and average daily withdrawals of 9 to 14 gpm. An estimate of the total direct evapotranspirational withdrawal over the entire stream length under study was made by using an average stream width of 4.7 feet, a length of 24 miles (DNRC, 1979) and the August, 1981 average daily corrected evaporation rate of 0.0168 ft/day, a mean of the U.S. Weather Bureau's Canyon Ferry and Moccasin experiment station pan data (U.S. Dept. of Commerce, 1982). The average evapotranspirational loss rate from the stream was thus estimated to be 52 gpm, or about 2.17 gpm per stream mile.

The total net streamflow losses to ground water, by difference, equalled 1013 gpm. Using more conservative criteria, stream losses to

infiltration and ground water would be occurring, when between two consecutive measurements, a loss remains after obtaining the minimum difference of each pair of measurements  $\pm$  5%, to allow for possible measurement error, minus 2.17 gpm/mi due to evapotranspirational effects.

Based on these criteria, seven of the eleven measured stream segments exhibited streamflow losses to infiltration ranging from rates of 7 to 108 gpm per stream mile. Losses to infiltration using the above criteria for all seven stream segments totaled 958 gpm. If all the gains in streamflow and evapotranspiration losses for the other four segments are subtracted, a net minimum overall streamflow loss to infiltration of 815 gpm remains.

A set of current meter measurements were made in August, 1982 to re-check stream seepage losses from several segments of Sand Coulee and Cottonwood Creeks. The results again confirmed a loss of about 100 gpm between Stockett and No. 5 Coulee on Cottonwood Creek. A very small gain was measured between No. 5 Coulee and CF03 and a gain of 168 gpm measured between CF03 and CF02.

A flow measurement was made on upper Sand Coulee Creek (T. 17 N., R. 5 E., 7, BA) about 17.5 stream miles above Centerville. At that point the flow was 2.9 ft 3/s, pH was near 7.0 and S.C. equaled 672 us/cm. Sand Coulee Creek at Centerville just above Cottonwood Creek discharged only 1-2 gpm, indicating that the mainstem of Sand Coulee Creek also loses substantial amounts of water to subsurface seepage.

Water quality data collected during seepage profiles (Appendix D (D-7)) indicate the major impact which AMD had on streamflow.

Cottonwood Creek above AMD influence had a pH of 7.33 to 8.26 and a

specific conductance of 418 to 476 us/cm. Downstream at Stockett, pH was 3.16 and S.C. equaled 1,641 us/cm. Just above Centerville, Cotton-wood Creek had a pH of 3.34 and an S.C. of 1,233 us/cm.

Sand Coulee Creek below Centerville had pH values ranging from 3.42 to 2.60, and S.C. values of 1,267 to 3,151 us/cm. The pH decreased below the confluence with Straight Creek, and S.C. showed a tendency to increase in the downstream direction, with the highest value just above the confluence with the Missouri River.

Effects of both evapotranspiration and acid neutralization reactions will increase the total dissolved solids concentration of the stream. Stream pH is affected markedly by both the influx of more acid or alkaline tributary water and by oxidation of dissolved ferrous iron to the rust-red ferric hydroxide precipitate which coats the channel of Sand Coulee Creek and produces additional acid.

## 2.4 Hydrologic Summary

The Sand Coulee Creek watershed has a dynamic hydrologic system in which the effects of acid mine drainage from abandoned underground coal mines plays a significant role in terms of volume and water quality impacts. Peak stream flows are of short duration and influenced primarily by spring and early summer rainstorms over the entire basin which extends to the Little Belt Mountains. Baseflow in streams originates primarily as ground-water discharge from the surficial Kootenai Formation, which is extensively fractured, and transmits meteoric recharge as ground-water flow to the contact with the underlying less permeable Morrison Formation, where springs and seeps contribute to streamflow. Where the Morrison coal seam has been mined, ground water leaks into the old workings where pyrite is oxidized, creating acid water which discharges to streams from old mine portals. From Stockett and Sand Coulee to the Missouri River, the baseflow of Sand Coulee Creek is primarily composed of acid mine drainage water. Very little of the acid baseflow leaves the watershed as streamflow, most of the water leaving either as evapotranspiration or being lost to subsurface seepage to alluvial and bedrock aquifers.

## 3. Chemical Modeling of Ground-Water Quality

### 3.1 Introduction

One of the significant discoveries of this project was the unanticipated poor chemical quality of ground-water sampled from some domestic wells in the study area. The dissolved solids, sulfate, and occasionally trace metal content of some Madison aquifer wells were much higher than the Madison ground water typically possessed even

farther down the flow system, namely, in the Great Falls vicinity.

The predominately downward vertical gradients, regional fracturing and solution permeability associated with the area create conditions favorable for leakage of acid mine drainage from contaminated streams and alluvium into lower aquifers, principally the Swift and Madison.

Chemical modeling calculations were conducted in an attempt to explain the mechanisms and dynamics of potential AMD contamination of the alluvial, Swift and Madison aquifers.

The primary objective of the modeling calculations was to provide some ideas on the constraints that equilibrium or near equilibrium mineral-aqueous phase relationships place upon the chemical composition of ground water. These results are then used to evaluate the mixing of various "type" waters. The result is a minimum and maximum value for the amount of acid mine drainage responsible for the impacted water quality of wells in the (deeper) Madison aquifer. The methodology employed is similar to that described by Plummer et al. (1983), using the program PHREEQE (Parkhurst et al., 1980). Acid-mine drainage from adit AS-03 was used as an end member type water. Two water samples, from the Kunesh and Net wells, were used as end member "uncontaminated" Madison type waters. The following sections describe the results of a pure mixing model and two different reaction models. We will compare the predicted product phases with cuttings from the planned 1983 drilling program to evaluate which of these models most closely resembles the natural system for further predictive input.

## 3.2 Mixing Model

The product of a mixing model is simply a synthetic water analysis

in which  $\underline{X}$  percent of water A is mixed with Y percent of water B (X + Y = 100) to yield a hypothetical water C, which is the best possible approximation of an observed water quality (water D). In order to accomplish this calculation, at least one constituent must be treated as "conservative," i.e., no additions or subtractions of this parameter occur. AS-03 drainage and the Kunish well water were used as waters A and B; sulfate, which constitutes the major anion species, was treated conservatively. The calculated mixing ratio is 19 percent AS-03 water and 8i percent Kunesh well water. Results of these calculations may be found in Table 3.

## 3.3 Reaction-Mixing Model 1

Because the mixing-model results provide a very poor correlation in terms of Fe, Ca, Mg, pH, and  $\mathrm{HCO}_3$ , a reaction model was used to evaluate the dissolution of limestone and dolomite by the acid mine drainage. Reaction steps for this model are: (1) precipitation of gibbsite and amorphous ferric hydroxide; (2) dissolution of calcite and dolomite plus precipitation of  $\mathrm{Al}(\mathrm{OH})_3$  and  $\mathrm{Fe}(\mathrm{OH})_3$ ; (3) degassing to atmospheric partial pressure of carbon dioxide ( $\mathrm{P}_{\mathrm{CO2}}$ ); and (4) mixing 19 percent modified AS-03 water with 81 percent Knox water and increasing the  $\mathrm{P}_{\mathrm{CO2}}$  to atmospheric. Results of this approach, shown as analysis E in Table 3, provide a reasonably good match with the water in the Knox well.

## 3.4 Reaction-Mixing Model 2

The major drawback to the first reaction-mixing model is that it ignored the supersaturation of the water with respect to gypsum.

Gypsum precipitation would remove sulfate from the water, thereby requiring a greater percentage of acid mine drainage to result in hypothetical mix water similar to that from an impacted well.

For this model, a low total dissolved solids well water (Net well), was used, and a less severely impacted Madison aquifer well (Senior Citizens well, Centerville) was the control well. Mass balance calculations were not used to control the mixing ratio. Instead, the modeling steps were: (1) react AS-03 water with limestone precipitating Fe(OH) $_3$ , Al(OH) $_3$ , and fluorite at saturation levels, precipitating gypsum at slightly supersaturated levels, releasing CO $_2$  once P $_{CO2}$  = 10  $^{-0.75}$  atmosphere, and dissolving calcite until slightly undersaturated; (2) mixing water from the previous step with Net well water, dissolving a small amount of dolomite and precipiating small amounts of chalcedony and calcite. This procedure required 45 percent modified AS-03 water and 55 percent Net well water to approximately match the water quality in the Senior Citizens well.

## 3.5 Discussion

The models provide insight as to the probable range of mixing within the Madison aquifer of acid mine drainage waters with "pristine" ground water. The authors hypothesize that plumes of significantly degraded water within the Madison aquifer are probably restricted to the areas immediately down gradient from discharging mines, in the vicinity of leaky Madison well bores and near acid contaminated streams traversing Madison outcrops or alluvial subcrops.

## 4. Evaluation of Proposed Mitigation Alternatives

Previous analyses of acid mine drainage treatments for the Sand Coulee area (McArthur, 1970; Hydrometrics, 1982) focused on centralized neutralization or mine manipulation methods. Knowledge of the hydrodynamics and hydrogeology of the AMD problem gained in this investigation allows new evaluations of old techniques and the suggestion of some new mitigation alternatives.

Five AMD control techniques were proposed for field testing in the Stockett-Sand Coulee area based on this and previous work by the Montana Bureau of Mines (MBMG) and others. In addition to being summarized below, the five methods were presented on a proposal to the Montana Department of State Lands (DSL) (Appendix E). They subsequently agreed to provide funding for field testing of two methods: infiltration control through increased evapotranspiration and drainage wells.

An investigation of the extent of acid mine drainage contamination in the alluvium of the lower Sand Coulee Creek watershed was proposed and also funded by DSL for 1983-84.

#### 4.1 Infiltration Control

A minimum of two test sites are proposed to monitor the effectiveness of perennial deep-rooted crops (eg. alfalfa and sanfoin) and flexible-cropping techniques in reducing ground-water recharge to the
Kootenai aquifer overlying the old coal mine workings. Research in
dryland saline-seep control has shown intensive cropping techniques to
be an effective tool in the control of shallow ground-water flow systems, when applied with a sound farm management plan. An organization
such as the Triangle Conservation District, Conrad, Montana, would
supply the required farm plan expertise to the farmers involved. Moni-

toring of ground-water level trends and of key AMD discharges would quantify the effectiveness of this approach.

## 4.2 Drainage Wells

Dewatering of the Kootenai aquifer with vertical wells may be possible, but is undesirable due to long-term pumpage requirements. We propose that horizontal test wells be drilled into the basal Kootenai sandstone aquifer upgradient from old mine workings at two sites.

Gravity drainage of Kootenai ground water will eliminate pumpage, may substantially reduce AMD discharge of the test sites and will make more fresh water available for dilution of remaining AMD in receiving streams. Horizontal dewatering wells have been used successfully in Montana for highway construction and mining purposes in the past.

Vertical connector wells which would allow gravity drainage of Kootenai ground water to the Madison aquifer, are another alternative which may be tested once detailed information on the aquifers and old mine workings is developed. Vertical test hole drilling and geophysical techniques would be used to map the location of old mine workings.

## 4.3 Subsurface Injection of AMD

Madison limestone rocks underlie the entire Sand Coulee watershed and could be an effective decentralized, disposal and neutralization medium for AMD. However, the Madison is also an important aquifer that must not be adversely impacted. Logging, sampling and analyses of Madison rocks from several test wells will indicate its physical characteristics. Aquifer testing and water quality sampling will be done to determine initial permeability characteristics estimate end products of

mixing AMD and Madison water. An initial 10-day injection test, and a second 100-day test would be conducted during which time extensive water quality and ground water level monitoring would be done. Following the tests, geophysical logs would be re-run on the test holes, aquifer test re-run to determine permeability changes and at least two new bore holes drilled and cored to sample precipitates. Hydrochemical modeling would be done to predict the long-term feasibility and impacts of an injection program.

#### 4.4 Flyash Neutralization

MBMG studies have documented the effectiveness of flyash in neutralizing pyrite induced acidity and reducing iron mobility of mine tailing waters (Sonderegger and Donovan, 1982). A field test of the effectiveness and maintenance requirements of a small flyash pit in neutralizing small acid discharges in the Sand Coulee area would be conducted. Pits of about 200 ft<sup>3</sup> in size would be filled with flyash and acid inflows of 1 gpm or less allowed to seep upward through the pits, being neutralized prior to discharge from the lower end. Water quality sampling and pit excavations would establish the effectiveness of the technique.

#### 4.5 Kootenai Neutralization

A simple and possibly effective AMD neutralization technique would be to mix naturally alkaline Kootenai ground water with small volumes of acid mine water. Mixing would occur in a pit where metals would be allowed to precipitate prior to discharge of the effluent. Typical AMD acidity and Kootenai ground-water alkalinity requires a 1 to 10

volumetric mix for theoretical neturalization. The technique will be evaluated by taking water quality samples and field measurements of the inflow and outflow.

## 4.6 Alluvial Ground-Water Contamination Mapping

The alluvial valley of Sand Coulee Creek joins an abandoned pre-glacial channel of the Missouri River. Residents all along lower Sand Coulee Creek abandoned alluvial wells years ago due to AMD contamination and even the Madison aquifer is contaminated in places. The many years of AMD seepage losses along the seven miles of old Missouri River alluvium have had a so-far undocumented impact on shallow ground-water supplies in the Great Falls area. It is proposed to conduct a reconnaissance shallow well drilling and sampling program in the old channel to document the extent of AMD contamination. Ground water flow gradients and the extent and severity of water quality conditions would be mapped.

# 5. Summary

The numerous abandoned underground coal mines in the Stockett-Sand Coulee area discharge a combined rate of  $1-4~{\rm ft}^3/{\rm s}$  of acid water (pH = 2-5) with a high dissolved and suspended metal load. The sources of the water is primarily downward leakage from the surficial Kootenai formation. The acid water comprises  $60-90~{\rm percent}$  of the total flow of Sand Coulee Creek in baseflow periods. Most of this flow is lost to evapotranspiration and leakage to alluvial and deeper bedrock aquifers, namely, the Swift sandstone (Jurassic) and Mission Canyon limestone (Mississippian) of the Madison group rocks.

Ground-water quality in the Kootenai aquifer is good, with TDS in the 300 to 450 mg/l range and alkalinity averaging about 340 mg/l as CaCO<sub>3</sub>. Water in the alluvium, downgradient from discharging acid sources is mostly contaminated such that very few domestic wells utilize this source. Water quality in the Swift and Madison aquifers is variable with unexpectedly high TDS and sulfate concentrations (maximum TDS = 2,413 mg/l, maximum sulfate = 1,580 mg/l) sampled in some domestic wells. This is believed to be caused by mixing with downward leaking AMD water from alluvium, well bores and places where contaminated streams traverse outcrops of Madison rocks.

A combination of AMD treatment techniques may prove to be the best long range mitigation approach. Five control measures were recommended for field testing: 1) infiltration control using intensive cropping methods in recharge areas; 2) connector and horizontal wells to dewater the Kootenai aquifer overlying the old mines; 3) injection and neutralization of acid water in the Madison limestone; 4) neutralization of small AMD sources in flyash pits; 5) neutralization of small AMD sources in pits with naturally alkaline Kootenai ground water.

TABLE 1 Correlations of Mine Designations Used in the Sand Coulee drainage.

MBMG No.	Location	Name	McArthur No. 5	Hydrometrics No
<sup>1</sup> AS-01	19N04E23ADCB	Upper Carbon Mine	23-6	SCM-2
AS-02A	19NO4E23ADAB	Lower Carbon Mine	23-5	SCM-3
AS-02B	19NO4E23ADAB	Lower Carbon Mine	23-5	
AS-04	19NO4E14DDED	Brown Mine	14-1	SCM-5
AS-06	19N04E13CBA			
2 <sup>AS-07</sup> 2 <sup>BS-01</sup> 3 <sup>CS-01A</sup>	19NO4E13CBD	Nelson Mine	13-3	SCM-6
2BS-01	18NO4EI4ACD	Giffen Mine	14-16	SCM-4
<sup>3</sup> CS-01A	19N05E07CACD	Tracy Mine	7-2	SCM-8
CS-01B	19N05E07CACD	Tracy Mine	7-2	SCM-8
CS-02	19N05E07DBC			
CS-03	19N05E18A			
CS-04	19N05E18DDC			
CS-05	19N05E19ACD			
CS-06	19N05E18DCC		13-6	SCM-11
CS-07	19N05E19BAA			
CS-08	19N05E19ABB			
CS-09A	18N05E06CDB	Number 6 Mine	6-1	SCM-9
4 <sup>CS-09B</sup> DS-01	18N05E06CDB	Number 6 Mine	6-1	
DS-01	19N05E20BBB			
SCM-7	19N05E07ABD	Badwater Johnson Mine	7-9	SCM-7
SCM-15	19N05E07AAAA	Goodwater Johnson Mine	7-8	SCM-15

<sup>1</sup> A: Straight Creek

B: Number Five Coulee
C: Sand Coulee Creek below Centerville

D: Sand Coulee Creek above Centerville

<sup>6</sup> McArthur, 1970 Hydrometrics, 1982

TABLE 2
Acid Discharge Characteristics, 1980-83

		Observed Range	2
	Flow		S.C.
Site	(gpm)	рН	us/cm
AS-01	43-500	2.21-3.01	4679-5349
AS-02a	7-26	1.99-2.82	2316-8047
AS-03	0-5	2.48-2.79	5363-6974
AS-04	45-67	3.84-4.20	3083-3487
AS-05	0-50	2.90-3.42	3352-3406
AS-06	0-38	2.80-3.10	1701-3469
AS-07	12.5-250	2.21-3.67	5023-10,306
BS-01	150-351	3.44-5.41	1038-8652
CS-01	14.3-39.7	2.28-2.88	1487-2103
CS-02	0-4.8	2.85	1387-1817
CS-06	0-0.61	3.45	8892
CS-07	1.1	2.27	15,732
CS-09	10.0-38.1	2.25-2.60	4865-7365
CS-10	0-80	1.50-2.55	10,114-10,591
DS-01	0-6	2.80	2283
SCM-7	5-15	2.3-2.35	2820-4243
SCM-15	3.8-7	3.02-6.3	1004-1100

Table 3. Major Element Water Chemistry for Modeling AMD Contribution to Impacted Wells.

	A AS-03	B Kunesh Well	C Synthetic Mix	D Knox Well	E Reaction Path l	F Net Se Well Cit	G Senior Re Citizens F	H Reaction Path 2
tab No.	8100057	79M3253		8101088	8	8200499 830	8300001	
Ca	292.	79.9	120.2	487.	456.	65.5	241.	204.
Mg	190.	32.	62.	146.	121.	23.6	135.	123.
Na	17.1	10.1	11.4	28.9	11.4	7.1	23.1	11.7
×	1.1	2.3	2.07	7.5	2.1	3.1	4.1	2.2
Fe	• 776	0.05	179.	0.15	0.045	0.018	<.002	0.012
Mn	2.84	4 0.00	0.54	0.016	0.53	0.002	0.004	1.292
$\sin_2$	116.	10.9	30.9	19.8	30.6	15.7	16.9	12.0
нсо3		235.	190.	261.	343.	271.	440.	636.
C1	2.0	6.4	4.3	5.1	7.7	3.1	23.3	2.6
804	7700.	145.	1580.	1580.	1562.	65.7	755.	747.
$NO_3(as N)$	1.7	0.32	0.58	6.04	1 1 1	5.69	12.4	!
ᄄ	12.8	0.57	2.89	99.0	97.0	0.50	1.1	0.85
Нф	3.38	8 7.4	4.10*	6.33	7.60	7.12	5.7	6.82
TDS	9280.	402.	2087.	2413.	2358.	324.	1411.	1417.
* pH = - 10	$^*_{pH} = -\log_{10} (0.19)$	$9 \times 10^{-} \text{pH}$ A)	) + (0.81 x	10 <sup>-p</sup> HB)				

TABLE 4
Selected Well Inventory Data for the Sand Coulee Area

NO. 1	AQUIFER	LAND ELEVATION ft, msl	TOTAL DEPTH ft	STATIC WATER LEVEL ft, msl	S.C. us/cm	DATE MEASURED <sup>2</sup>
)1	Alluvium	3800	35	3784.02	983	6-4-82
: 1	Kootenai	4303	90	4228.12		8-19-82
12	Kootenai	4075	131	4057.32	677	6-21-82
(3	Kootenai		75	4356.18	506	8-19-82
11	Jurrassic	3695	58	3665.52		6-2-82
12	Jurrassic	3390	100	3365.27	1336	5-27-82
(1	Madison Limestone	3440	158	3338.64	612	6-9-82
12	Madison Limestone	3430	168	3320.22	700	6-18-82
13	Madison Limestone	3457	175	3374.44	595	6-5-82
14	Madison Limestone	3455	220	3448.67	1667	6-4-82
15	Madison Limestone	3460	185	3311.32	617	6-10-82
16	Madison Limestone	3455	175	3375.24	597	6-19-82
17	Madison Limestone	3475	200	3352.08	2292	6-9-82
18	Madison Limestone	3510	290	3313.1	826	6-20-82
19	Madison Limestone	3490	258	3408.3	2911	6-2-82
110	Madison Limestone	3400	125	3334.19	1698	5-28-82
111	Madison Limestone	3418	200	3345.85		5-28-82

Refers to Figure 6.

All measurements by MBMG.

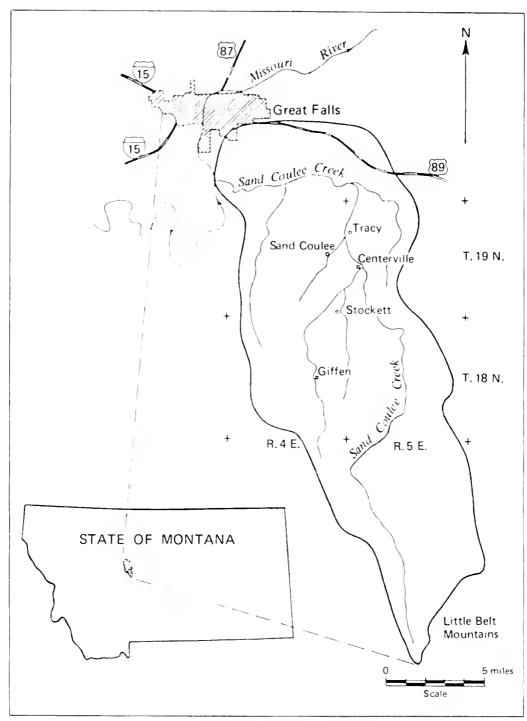


Figure 1. Location of study area.

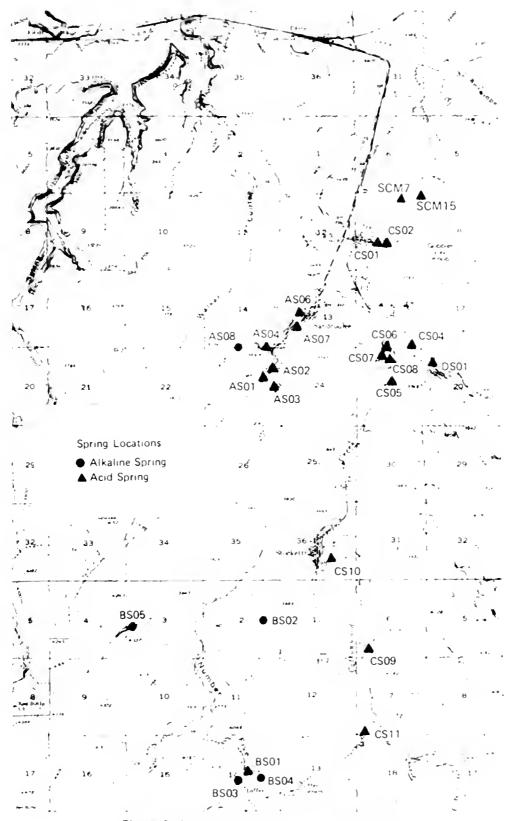


Figure 2. Location of springs and acid discharges.

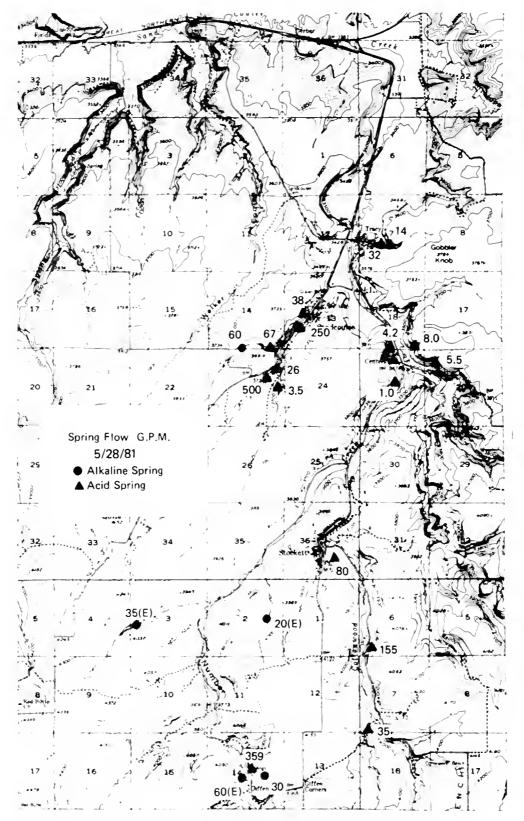


Figure 3. Discharge, in gallons per minute, of springs on May 28, 1981.

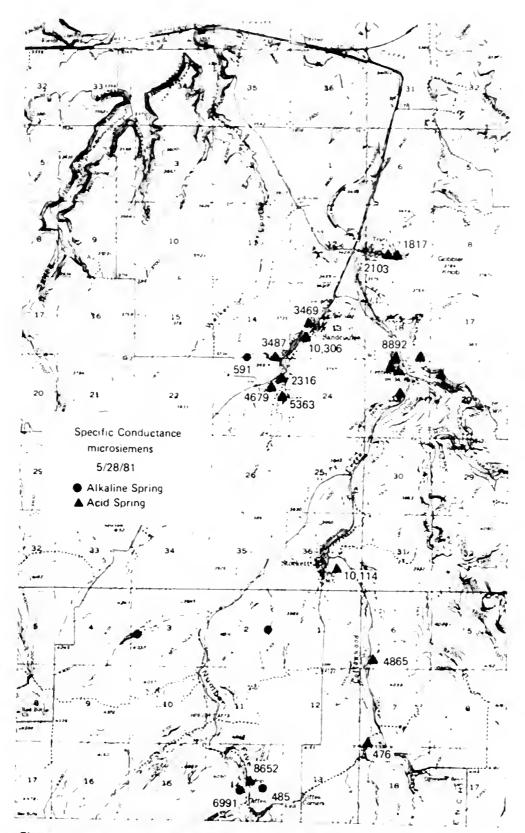


Figure 4. Specific conductance of springs in microsiemans/cm ( $\mu$ S/cm) on May 28, 1981.

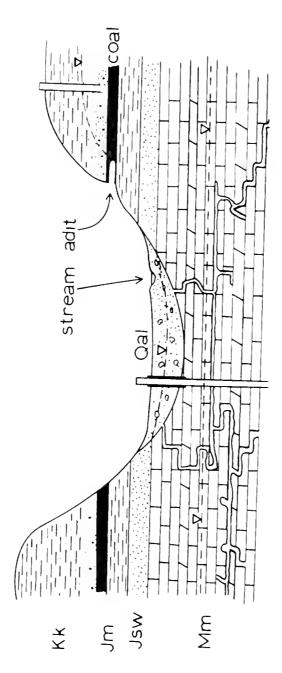


Figure 5. Schematic cross section through a coulee. Not to scale. Kk=Kootenai Formation; Jm=Morrison Formation; Jsw=Swift Formation; Mm=Madison Group. Thickness of the coal and the Swift Formation are exaggerated. The symbol abla represents the water table.

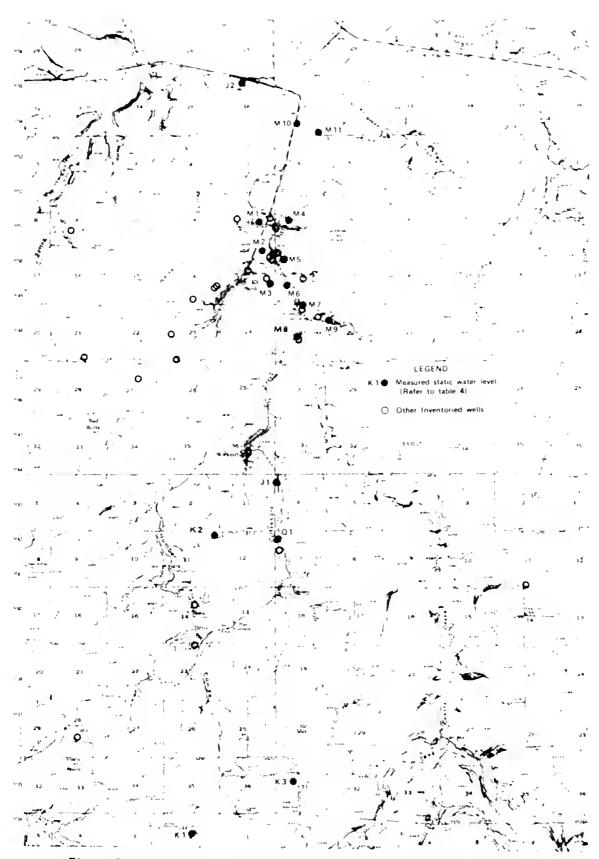


Figure 6. Location of domestic wells inventoried by MBMG, 1982.

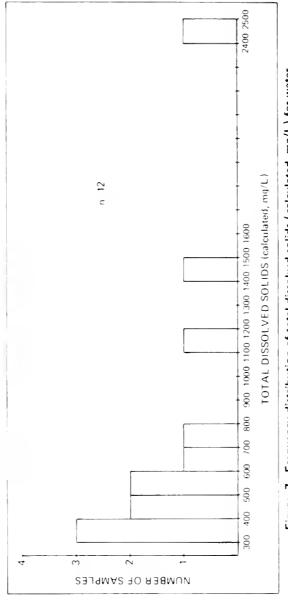


Figure 7. Frequency distribution of total dissolved solids (calculated, mg/L) for water samples from the Madison aquifer, Sand Coulee area, Montana.

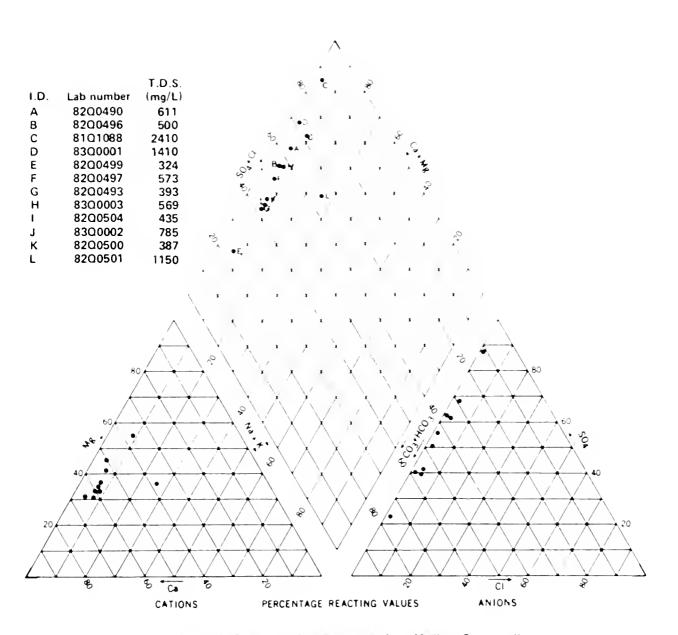


Figure 8. Piper plot of water analyses from Madison Group wells, Stockett - Sand Coulee area, Montana.

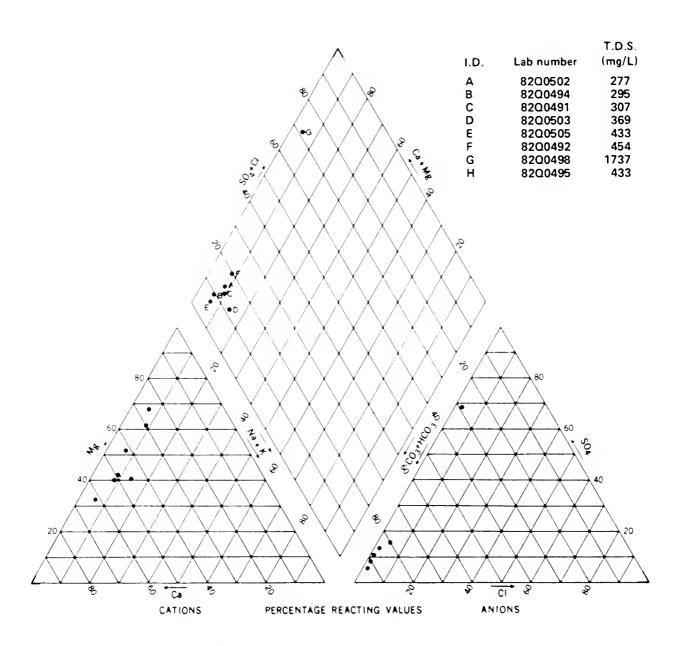


Figure 9. Piper plot of water analyses from Jurassic and Kootenai wells, Stockett-Sand Coulee area, Montana.

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# APPENDIX A SPRING AND ACID DISCHARGE DATA

A-1

SPRING MONITORING DATA

:172 498 SC I 8.48 8.45 AS08. 1 300 FLOW 上市 21 1 5023 5622 5667 7152 1030 5577 6365 SC  $\odot$ 2.40 2.50 3.67 25 2.38 3.20 2.35 2.21 H AS07 ලා <u>ه</u> 12.5 E = estimated value S.C. units in µS/CM (micro-mhos/cm 3406 40 E 276269.8 F1,0W Reference point SCLOPA 250 31 70140 1007 781 2.99 2.90 80 3.10 3.02 2.80 100 AS06 2 Spring Monitoring Data FLOW 2.2 0.7 2.9 1.2 38 1 3083 3225 3287 2380 3329 2490 SC .20 4.20 3.70 Ξ 4.12 3.84 3.84 AS04 4 6974 18.6 14.1 S FLOW MdS 4 [cs] site 29 35 67 6622 5363 5414 Remarks: 6673 SC 2.59 2.67 2.62 2.48 2.79 Hi Hote plugged by Ice or snow AS03 1.58 3.5 ~ FLON de S 1 2 7045 2316 6201 6498 7173 6786 8047 5689 SC Styhon in hole · Hole offed in FI . Hele filled in 1.99 2.37 2.82 2.77 2.36 2.46 2.47 <u>=</u> 1 F :17 11.6 10.2 10.2 10.1 FT.OM GPN 18 7 26 1 valve above GS
A = Hole abondoned
D = Dry hole 5172 5349 1989 5055 |4679 5231 5102 - Howing well SC Sand Coulee HC 2.55 2.62 2.64 2.85 2.81 2.21 3.01 1 AS01 Coding abbreviations: E-15 FLOW 500 2.4 103 43 6/1-6/3/80 12/30/82 9/21/80 5/28/81 8/18/81 GS-MP 3/5/81 3/6/83 2/5/82 Well No Dofe

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		A = Hole abandoned D = Dry hole F = 1 towfrg well	abandoi hole drg well	s - s	S with no hole.	undid by	10 of 2	mow.							and the second				1	1	1 1
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											6										
5/28/81	359	4.21	8652							000	8.08	482									
8/18/81	351	3.44	2039																		
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6737 6923 6226 SC 2.60 2.45 2.53 CS09 HC W.043 9 9 SC DRY DRY Ĭ CS07 \ppcndix Referrnce point 5114 889 SC 3.45 2.71 Ξ 9080 Rumarks: Spring Monitoring Data 9,0 76. 1904.5  $\sim$ SC 1 II CTUALIONS DRY DRY Hd **CS05** F.F.P. fest site ペー メニノ シ SC PH DRY DRY CS04 1 . Hole plugged by ke or mow S. Siphon in hole SPOW PPOW į 1817 St . Role wifed in FI Heb filled in SC1 2.85 ИС CS02 DRY 4.8 Š Č L D Civing abbreviations: • • Valve above GS

A = Hole abandoned

D = Dry hole

F = Flow Eq. 4.18 1490 1862 SC Hd 2.88 2.77 Sand Coulee CS01 14.3 20E 6/1-6/3/80 Le saint 9/21/80 G S - ₹P dell No. 3/5/81 Date

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SPRING WATER QUALITY LABORATORY ANALYSES

BUTTE, MONTANA 59701 (406)498-4101

WATER QUALITY AMALYSIS UAB NO. 8002318

STATE HONTANA
LATITUDE-LONGITUDE 47023/12\*N 111010/49\*W
UTM COORD(NATES 212 NS247870 E486410
TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1
GFOLOGIC SOURCE 221MRSN\* \* \* CASCADE 19N 1F 23 ADED 50 ASO1 47231211110170. MINE DRAINAGE 3500. FT 10 YTHUOS HOLTASOJ BYLS BIJC DMAN TOPOGRAPHIC MAP GFOLOGIC SOURCE DRAINAGE BASIN ILES 7 1 STATION TÜ \* SAMPLE SOURCE JANG SURFACE ALTITURE B.B AGENCY + SAMPLER BOTILE NUMBER DATE SAMPLED SUSTAINED YIELD YIELD MEAS METHOD INCL\*ONRE AS-01 TOTAL DEPTH OF WELL 20-SEF 30 TIME SAMPLED 09:00 HOURS SWL AROVECTOR DELOW GS LAB + ANALYST DATE ANALYZED SAMPLE HANDLING CASING DIAMETER CASING TYPE COMPLETION TYPE MBMG # ENA 09-MAR-81 4120 METHOD SAMPLED GRAB PERFORATION INTERVAL WATER USE UNUSED

SAMPLING SITE SAND COULEE MINING DISTRICT\*NO-NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION

	MG/1.	MERZL			HG/1	MEGZI
CALCIUM (CA)	L90.	9.48	BICARRONATE	CHCOS/		
MAGNESIUM (MG)	122.	10.04	CARBONATE	(003)		
SODJUH (NA)	19.4	0.84	CHLORIDE	(CL)	3.1	0.07
PÖTÁSSTUM (K)	3	0.01	SULFATE	(504)	4500.	95.77
IRON (FE)	712.	38.25	NITRATE	(AS N)	.01	0.00
MANGANESE (MN)	2.03	0.07	FLUORIDE	(F)	1.70	0.22
SILICA (SIO2)	88.8		PHOSPHATE TOT	(AS F)		
TOTAL CATIONS		58.69	TOTAL	SHOIMS		98.00

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA)

LABORATORY PH	2.70	TOTAL HARDNESS AS	CACO3	978.50
FIELD WATER TENPERATURE	10.0 C	TOTAL ALKALINITY AS:	CACOZ	
CALCULATED DISSOLVED SOLIDS		SODIUM ADSORPTION	RAITO	0.27
SUB OF DISS. CONSTITUENT		RYTHAR STABILITY	xnnex	
LAR SPEC.COND.(MICROMHOS/CM)	4568.	LANGLIER SATURATION	INDEX	

PARAMETER	VALUE	PARAMETER	VAI. UE
TEMPERATURE, AIR (C)	13.0 C	CNDUCTVY+E1ELD MICROMHOS	5102.
FIFLD PH	2.62	ALUMINUM, DISS (MG/L-AL)	393.
NICKEL/DISS (MG/L AS NI)	3.96	SILVER,DISS (MG/L AS AG)	0.002
LEAD+DISS (MG/L AS PR)	<.04	BURON (DISS (MG/L AS B)	.16
STRONTTUH+DISS (MG/L-SR)	.95	CADHIUM,DISS(MG/L AS CX)	.011
TITANIUM DXS(MG/L AS TI)	.065	CHROMIUM, DISS (MG/L-CR)	. 27
VANADIUM,DISS(MG/L AS V)	.34	COPPERINTSS (MG/L AS CU)	. 1.5
ZINC+DISS (MG/L AS ZN)	17.6	LITHIUM,DISS(MG/L AS LI)	.52
ZIRCONIUM DIS(MG/L AS ZR	.040	MOLYBDENUM;DISS(MG/L-NO)	.03
ARSENIC:DISS(UG/L AS AS)	30.4	MERCURY+DISS(UG/L AS HG)	03
SELENIUM, DISS (UG/L-SE)	1.7	ACTIVITY: TOT (MG/L-CACO3)	4695.

REMARKS: FINE WHITE PRECIPITATE IN WATER "BECOMES GRANGE PRECIPITATE UPON REACHING CREEK \* MINE OUTFLOW " HEAD OF NO-MANE COULEF (SITE AS=01) : LAB: H+=41.1 MG/L \* 40.7 MEDV/L> SIGMA -10.3> 1.4 TOTAL CALION MEDVS/L \*

EXPLANATION: MG/L = MILLIGRAMS FER LITER, UG/L = MICROGRAMS FER LITER, MER/L = MILLIFOU) VELENTS FER LITER. FT = FEET, MT = METERS. (A) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. IR = TOTAL RECOVERABLE. TOT = TOTAL.

QU WA SO WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 04-MAY-81 BY: IF \*CLG
PROCESSING PROGRAM: F1730F V2 (11/3/81) FRINTED: 27-MAY-03

PERCENT MEQUL (FOR PIPER PLUT)

CA MG NA K OL 504 H003 C03
46.5 49.3 4.1 0.0 0.1 79.9 0.0 0.0

HOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 0002316

#### NATER QUALITY ANALYSIS LAB NO. 8101086

STATE HONTANA SITUDE 47023/12\*N 111010/49\*W NATES 712 N5247890 E486410 C HAP SOUTHEAST GREAT FALLS 7 1 SOURCE 221HRSN\* \* \* .AND SU COUNTY CASCADE SITE LOCATION 19R 04E 23 ADCB LATITUDE-LONGITUDE 45°W SITE LOCATION
HANG SITE
HALS 7 1 STATION ID
\* SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
YIELD HEAS HETHOD
TOTAL DEPTH OF WELL
ABOVE(") OR BELOW GS
CASING DIAMETER UTM COORDINATES 712 N5247870 (
UTM COORDINATES 712 N5247870 (
TOPOGRAPHIC MAP SOUTHEAST GREAT
GEOLOGIC SOURCE 221MRSN\*
DRAINAGE BASIN BB
AGENCY + SAMPLER MBMG\*ABM
BOTTLE NUMBER AS\*\*01
DATE SAMPLED 14\*\*JUL\*\*B1
TIME SAMPLED 14\*\*JUL\*\*B1
LAR + ANALYST MBMG\*ENA AS01 472312111104901 HINE DRAINAGE 3500. < 10 LAR + ANALYST DATE ANALYZED SAMPLE HANDLING HBMG\*FNA CASING TYPE METHOD SAMPLED WATER USE PERFORATION INTERVAL GRAD UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT\*NO-NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION MG/I. HER/L MG/I. HE G/L 173. 122. (HC03) .0 8.63 BICARBONATE CALCIUM (CA) 10.04 CARBONATE (003) .0 MAGNESIUM (MG) 0.18 100.75 0.06 0.43 (NA) 0.70 CHLORIDE (CL) 6.5 SOBTUK 13.1 .27 0.01 45.25 0.07 4835. SULFATE (SD4) (K) POTASSIUM ໌.85 ຄ.12 861.75 NITRATE (AS N) IRON MANGANESE (HN) PLUORIDE (F) 71.6 PHOSPHATE TOT (AS P) SILICA (SIO2) 101.42 TOTAL ANIONS TOTAL CATIONS 65.70 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) TOTAL HARBNESS AS CACO3 LABORATORY PH 2.56 534.13 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS 12.1 SODIUM ADSORPTION RATIO 0.23 RYZNAR STABILITY INDEX LANGLIER SATURATION INDEX SUH OF DISS. CONSTITUENT SPEC.COND. (MICROHHOS/CM) 5157. PARAMETER VALUE PARAMETER VALUE CARAMETER
CARACTER
CARUCTVY, FIELD MICROMHOS
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
BORON, DISS (MG/L AS B)
CARMIUM, DISS (MG/L AS CU)
CHROMIUM, DISS (MG/L AS CU)
LITHIUM, BISS (MG/L AS CU)
LITHIUM, BISS (MG/L AS CU) 20.0 5357. 433. TEMPERATURE, AIR (C) FIELD PH ₹.002 27 884 NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L AS PR) 4.32 <.004 .93 .024 .35 STRONTÎUH, DISS (MGZL-SR) TITANIUM DIS(MGZL AS TI) VANADIUM, DISS(MGZL AS V) ZINC:DISS (HG/L AS ZN) ZIRCONIUM DIS(HG/L AS ZR IRON:TR (HG/L AS FE) ≤.004 HOLYBRENUH, DISS (HG/L-HO) SELENIUM, TR (UG/L AS SE ACIDITY, TOT (HG/L-CACO3)

REMARKS: WATER VERY FROTHY AND FOAM COVERED AFTER DISCHARGE HINE OUT FLOW, HEAD OF NO-NAME COULEE (SITE AS-01) H4 OF 81.73 MG/L GIVES 100.5 MED CATIONS GIVES .6 SIGMA

466.

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/HILLIGROUPELENTS PER LITER, FT = FEET, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

U.M. MA 32 OW  $\Delta T$ 

OTHER AVAILABLE DATA OTHER FILE NUMBERS: 8002316

ALUMINUM, TR (HG/L AS AL)

cost: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: 19 FEB-82 F1730P V2 BY: PRINTED: TP #UKS 27-MAY-83 (11/3/81)

> (FOR PIPER PLOT) PERCENT MERZI 0.Z 0.0 304 HC03 CA MG 44.6 51.8 003 MG

IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: HOTE:

4060.

WATER QUALITY ANALYSIS LAB NO. 8002317

STATE MONTANA COUNTY CASCADE SITE LOCATION 19N 4E 23 AADC HRNG SITE AS- 02 STATION ID 4/2321111103801 SAMPLE SOURCE HINE BRAINAGE TTTUDE-LONGTTUDE 47D23/21\*N 111D10/30\*N UTM COGRDINATES 712 NS248190 F486595 TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 LATITUDE - LONGTYUDE GEOLOGIC SOURCE 22 DRAINAGE BASIN BB ??IMRSN\* \* \* LAND SURFACE ALTITUDE 3570. FT . 10 AGENCY + SAMPLER MBMG\*JJD BOTTLE NUMBER AS-02 SUSTAINED YIELD YIRLD MEAS HETHOD DATE SAMPLED 20-SEP-BO TIME SAMPLED 09:30 HOURS LAR + ANALYST MRMG\*FNA DATE ANALYZED 09-MAR-BI SAMPLE HANDLING 41:20 TOTAL DEPTH OF WILL ABOVE(-) OR RELOW GS CASING DIAMETER SWI CASING TYPE HETHOD SAMPLED GRAD PERFORATION INTERVAL WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT\*NO NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION HG/L ME Q / L MG71. MEGZL 9.48 BICARBUNATE 9.71 CARBUNATE CALCIUM (CA) 190. (HC03) MAGNESIUM (MG) 118. (003) 15.9 SODIUM (NA) 0.67 CHLORIDE (CL) 0.5 0.07 | ≤ . 15 SULFATE NITRATE 5400, COTASSIUM (K) (504) 112.43 502. 2.54 26.97 IRON (FE) (AS N) .01 HANGANESE 0.09 FLUORIDE (F) (MN) 1,97 0.26 SILICA (SIG2) PHOSPHATE TOT (AS F) 104.0 TOTAL CATIONS 46.94 TOTAL ANIONS 112.76 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 2.49 TOTAL HARDNESS AS CACO3
9.6 C TOTAL ALKALINITY AS CACO3
SODIUM ADSORPTION RATIO
RYTHAR STABILITY INDEX
2. LANGLIER SATURATION INDEX LABORATORY PH 960.12 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND.(MICROMHOS/CM) 0.22 5292. PARAMETER VALUE PARAMETER VALUE CNDUCTVY+FIELD MICROMNOS ALUMINUM: DISS (MG/L-AL) 5389. TEMPERATURE, AIR (C) 14.0 C FIELD PH 481. 2.46 NICKEL,DISS (MG/L AS NI) LEAD,DISS (MG/L AS PR) STRONTIUM,DISS (MG/L SR) IITANIUM DIS(MG/L AS TI) STLUER, DISS (NG/L AS AD) BORON, DISS (MG/L AS B) CADMIUM, DISS (MG/L AS CD) .002 4.6 <.04 .19 .74 . 11 .069 CHROMIUM, DISS (MG/L-CR) 23 COPPERIDISS (HG/L AS CU) VANADIUM, DISS(MG/L AS V) .15 LITHIUM, RISS(MG/L AS LI)
MOLYRUENUM, RISS(MG/L AS LI)
MERCURY, RISS(UG/L AS HG)
ACIRITY, TOT(MG/L-CACO3) ZINCODISS (MG/L AS ZN) ZIRCONIUM DIS(MG/L AS ZR .63 19.5 ARSENICIBLES (UGZL AS AS) SELENIUM, DISS (UGZL-SE) .03 4560. 1.4 REMARKS: WAIER IS PALE YELLOW - BECOMES GRANGE UPON REACHING CREEK \*
SPRING DRAINAGE FROM MINE ADIT AS-02 \* JUST ABOVE LANDFILL - SAND
COULEE \* DISCHARGE FROM ADIT (CAVED) AND OLD WOOD DRAIN PIPE \*
LAB: HF=46.6 MG/L \* 46.2 MERVS/L, SIGMA .97, 111.0 TOTAL CATION MERVS/L \* EXPLANATION: MGZL = MILLIGRAMS PER LITER, UGZL = MICROGRAMS PER LITER, MEGZL HILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MFASURFD; (E) = ESTIMATED; (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL. MA S2  $\Omega \mathbf{U}$ OTHER āΤ OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PERCENT MED/L (FOR PIPER PLOT)

CA MG NA K DL S04 HC03 C03

47.7 48.8 3.5 0.0 0.1 22.7 0.0 0.0

COST:

PRINCED:

BY:

TF: \*CLG

27-HAY-83

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8002317

F1730F V2 (11/3/81)

01-MAY-81

PROJECT:

LAST EDIT DATE:

PROCESSING PROGRAM:

#### WATER QUALITY ANALYSIS LAB NO. BOR2318

STATE LATITUDE - LONGITUDE CASCADE ANATHOM COUNTY 19N 4E 23 AADD 45-03 472320111103201 MINE BRAINAGE 47023/20"N 111010/32"W 712 N5248180 E486755 SOUTHEAST GREAT FALLS 7\_1 SITE LOCATION HBMG SITE STATION ID SAMPLE SOURCE FACE ALTITUDE UTH COURDINATES TOPOGRAPHIC MAP GEOLOGIC SOURCE DRAINAGE BASIN \* ??INRSN\*IIILNFL\* LAND SURFACE ALTITUDE SUSTAINED YIELD YIELD MEAS METHOD 3530. ÈÈ FT < BASIN AGENEY I SAMPLER BOTHE NUMBER **MRHG\*JJD** OTHE NUMBER DATE SAMPLED LIME SAMPLED AS 03 20-SEP-80 TITAL DEFIH OF WELL
ABOVE(-) OR RELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE 10:00 HOURS SWL LAR + ANALYST DATE ANALYZED SAMPLE HANDLING HRMG\*FNA 09-MAR-81 4120 METHOD SAMPLED GRAB PERFORATION INTERVAL WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT\*NO-NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION HER/L MG/L MERZIL MG/L 426. 196. 20.2 21.23 15.30 (HC03) BICARBONATE (CA) CALCIUM CARBONATE (003) HAGNESTUM (MG) 0.14 5.8 0.38 CHUGRIDE (CL) SOBTUR (NA)  $\{.15$ 6520 L SULFATE (504) POTASSIUM (K)674. 9.67 36,21 NITRATE (AS N) .04 IRON (FE) 0.35 FLUORIDE (F) 5.7 0.35 HANGANESE (MN) PHOSPHATE TOT (AS P) (\$102) 117.0 SILICA TOTAL ANIONS 136,27 74.00 TOTAL CATIONS STANDARD DEVIATION OF ANION-CATION BALANCE (SISHA) LABORATORY PH 2:65 TOTAL HARDNESS AS CACOS 1829,30

LABORATORY PH 2.65 TOTAL HARDNESS AS CACO3 1829.30
FIELD WATER TEMPERATURE 23.8 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SONIUM ADSORPTION RATIO 0.21
SUB-OF-RISS CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOS/CM) 5726. LANGLIER SATURATION INDEX

VALUE	PARAMETER	VALUE
14.0 C	CNDUCTVY, FIELD HICROMHOS	5414.
2.62	ALUMINUM, DISS (MS/L-AL)	552.
5.31	SILVER,DISS (MG/L AS AG)	.006
< , 0.4	BORON →DISS (MG/L AS B)	• 52
1.26		.057
. 1 1		. 20
.06		, <u>05</u> 9
21.1		.70
.041	· · · · · · · · · · · · · · · · · · ·	<.02
< . 1	MERCURY→DISS(US/L AS HS)	<.03
1.2	ACIDITY FOT (MG/L ~CACC3)	4675+
	14.0 C 2.62 5.31 <.04 1.25 .11 .06 21.1 .041 <.1	(4.0 C CNDUCTVY,FIELD NICROMHOS 2.62 ALUMINUM, BISS (MG/L-AL) 5.31 SILVER,DISS (MG/L AS AG) <.04 BORON ,DISS (MG/L AS B) 1.26 CADMIUM,DISS (MG/L AS CD) .11 CHROMIUM, DISS (MG/L AS CD) .06 COPPER,DISS (MG/L AS CU) 21.1 UTHIUM,DISS (MG/L AS CU) .041 MOLYBDENUM,DISS (MG/L AS CU) <.1 MERCURY,DISS (UG/L AS HG)

REHARKS: WATER IS PALE GRANGE - BECOMES BRIGHT RED UPON REACHING CREEK \* SPRING AS-03 - FLOWING THRU SAND COULEE LANDFILL \*

SAMPLE TAKEN JUST BELOW LANDFILL \* LAB! HE=36.7 HG/L \* 36.4 MERV/L, SIGMA .65 \* 130 TOTAL CATION MERVS/L \*

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEQ/L HILLIEGUIVELENTS PER LITER. FT = FEET, MT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW NA S2 WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST FRIT RATE: 04-MAY-81 BY: TP \*CLC
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT HEG/L (FOR PIPER PLOT)
CA HG NA K CL SO4 HC03 CO3
56,8 40,9 2.3 0.0 0.1 27.7 0.0 0.0

HOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8002318

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STATE MONIANA

LATITUDE-LONGITUDE 47D33/14*N 111D10/39*W SITE 1 CCATION 19N 4F 23 ABAC UTM CODRBINATES 712 N524790 E406020 HBMG SITE 60 03 TOPOGRAPHIC MAP COUTHEAST GREAT FALLS 7 J STATION ID 472314111103901 GEOLOGIC SOURCE 221MRSN* * CAMPLE SOURCE HINE DRAINAGE DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3570, FT 50 AGENCY + SAMPLER MEMG*JJB SUSTAINED Y1ELD ASSOCIATION ASSOCIATION BOTTLE NUMBER AS-03 YLEID HEAS METHOD DATE SAMPLED 03-MAR-81 TOTAL DEPTH OF WELL TIME SAMPLED 11:00 HOURS GWL ABOVE(-) OR RELOW GG LAB + ANALYST MEMG*FNA CASING DIAMFTER DATE ANALYZED 22-APR-81 CAGING TYPE SAMPLE HANDLING 4120 COMPLETION TYPE * HETHOD SAMPLED GRAB PERFORATION INTERVAL WATER USE UNUSED
                               E HANDLING 4120
OD SAMPLED GRAB
WATER USE UNUSED
                SAMPLING SITE STOCKETT - SAND CODLEE HINING DISTRICT GEOLOGIC SOURCE MORRISON FORMATION
                                                                                                                                                                                 HSZI HERZE
                                                                MG/L
                                                                                         HEQ/L
                                                             292.
190.
17.1
                                                                                                                                                     (RG33)
                                                                                          14.57 BICARBONATE
                                        (CA)
             MULDIAC
                                                                                          15.63 CARBONATE
0.74 CHLORIDE
0.03 SULFATE
            HAGNESTUM (MG)
                                                                                                                                                                                7700.
1.70
12.8
                                                                                                                                                          (CL)
                                                                                                                                                                                                             0.06
             SODIUM
                                        (NA)
             POTASSIUM (K)
                                                                                                                                                         (504)
                                                                                                                                                                                                         160.31
            IRON (FE)
MANGANESE (MN)
SILICA (SIO2)
                                                                                                                                                                                                           0.12
                                                                744.
                                                                                            50.71 MITRATE
0.10 FLUCRIDE
                                                                                                                                                       (AS N)
                                                                 2.84
                                                                                                                                                              (F)
                                                                                                              PROSPHATE TOT (AS P)
                                                                113.0
                   TOTAL CATIONS
                                                                                             81.79
                                                                                                                                     TOTAL ANIONS
                                                                                                                                                                                                          161.17
                  STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA)
                                               LARGRATORY PH
                                                                                                   2.77
                                                                                                                          TOTAL HARDNESS AS CACOS
                                                                                                                                                                                               1511,16
                                                                                                  8.1 C TOTAL ALKALINITY AS CACOJ
SODIUM ADSORPTION RATIO
RYZNAR STARILITY INDEX
                  FIELD WATER TEMPERATURE
    CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(MICROMHOS/CM) 6710.
                                                                                                                                                                                                          0.17
                                                                                                               LANGLIER SATURATION INDEX
TEMPERATURE, AIR (C)
TEMPERATURE, AIR (C)
FIELD PH
ARSENIC, TR (UG/L AS AS)
SCLENIUM, TR (UG/L AS SE)
ALUMINUM, DISS (MG/L AS AG)
BORON DISS (MG/L AS B)
CADMIUM, DISS (MG/L AS CB)
CHROMIUM, DISS (MG/L AS CB)
COPPER, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS CU)
SELENIUM, DISS (UG/L AS AS)
SELENIUM, DISS (UG/L AS AS)
                                                                                                                                                                                                    VALUE
                                                                                                                                                                                                8510.
752.
1210.
                                                                                                                                                                                              3002.
5.15
5.04
                                                                                                                TITANIUM DIS(MG/L AS TI)
VANADIUM,DISS(MG/L AS TI)
VANADIUM,DISS(MG/L AS TV)
ZINC,DISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR
ARSENIC,DISS(UG/L AS AS)

C2.1
 REMARKS: WATER TURBID-FILTERS CLEAR*ORGANIC MATTER: AL-HYDROXIDE IN FILTERATE SAMPLE TAKEN AT ADIT MOUTH - ABOVE SAND COULEE LANDFILL * LAD: 150.0 TOTAL CATION MEGVS, 2.95 SIGMA, EST HE 48 MG/L *
 EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L = HILLIEQUIVELENTS PER LITER, FT = FEET, MT = METERS, (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.
                                                                   UП
                                                                              WA
                                                                                          32
                                                                                                     U T
                                                                                                                 UL
                                                                                                                            FILL
                                                                                                                                        AT
                                                                                                                                                              DIHER
 OTHER AVAILABLE DATA OTHER FULF NUMBERS:
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:TCOO :YR

TP #CLC 27 HAY 83

PERCENT HERZEL (FOR PIPER PLOT) CA \_ MG \_ NA \_ K \_ CL \_ SO4 HCC3 CA M6 0.03 0.1 0.0100.0 0.0 0.0

27-A28-81

CROUECT:

LAST EDIT DATE: PROCESSING PROGRAM:

IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8180057 NOTE:

F1730F V2 (11/3/81) PRINTED:

#### WATER QUALITY ANALYSIS LAB NO. 8002319

COUNTY CASCADE STATE HONTANA 47D23'34"N 111D10'46"W Z12 N5248670 E486570 SOUTHEAST GREAT FALLS 7\_1 SITE LOCATION 19N 4E MBMG SITE AS-04 14 DECE LATITUDE-LONGITUDE UTH COORDINATES TOPOGRAPHIC MAP MÉS 7 1 STÁTION IÐ 472334111104601 \* SAMPLE SOURCE MINE DRÁINAGE LAND SURFACE ÁLTITUDE 3540. FT < 50 DRAINAGE BASIN \* 221MRSN\* EE SUSTAINED YIELD AGENCY & SAMPLER BOTTLE NUMBER ALL\*SHAM SUSTAINER TIELD
YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL AS-04 DATE SAMPLED TIME SAMPLED 70-SEP-80 12:00 HOURS LAR + ANALYST DATE ANALYZED SAMPLE HANDLING METHOD SAMPLED HSHG\*FNA 09-MAR-01 41.20 GRAB WATER USE UNUSED SAMPLING SITE SAND COULEE MINING DISTRICT\*NO-NAME CREEK GEOLOGIC SOURCE MORRISON FORMATION

(AD) MUIDHAD	MG/L 171.		BICARBONATE	(8003)	MG/I.	MEG/L
HAGNESIUH (HG) SODIUH (NA) POTASSIUH (K)	133. 23.5 4.4	1.02	CARBONATE CHLORIDE SULFATE	(CD3) (CL) (SO4)	4.9 3560.	0.14 74.12
IRON (FE) MANGANESE (MN) SILICA (SIO2)	436. 1.63 54.5		NITRATE FLUORIDE PHOSPHATE TOT	(AS N) (F) (AS C)	<.02 3.31	0.17
TOTAL CATIONS		44.07	TOTAL	ANIONS		74.43

STANDARD DEVIATION OF ANION-CALLON BALANCE (SIGMA)

LAMORATORY PH	3.04	TOTAL HARDNESS AS (	DACO3 974.42
FIELD WATER TEMPERATURE	15.0 C	TOTAL ALKALINITY AS (	CACO3
CALCULATED DISSOLVED SOLIDS		SODIUM ADSORPTION (	
SUM OF DISS. CONSTITUENT		RYZNAR STABILITY :	
LAB SPEC.COND.(HICROHHOS/CH)	3638.	LANGLIER SAYURAYION :	XNDEX

PARAMETER TEMPERATURE, AIR (C) FIELD PH NICKEL, DISS (MG/L AS NI) LEAD, BISS (MG/L AS PB) STRONTIUM, DISS (MG/L AS TI) VANADIUM, DISS (MG/L AS TI) VANADIUM, DISS (MG/L AS ZN) ZIRCONIUM DIS (MG/L AS ZR) ARSENIC, DISS (MG/L AS AS)	VALUE C 14.84 3.84 2.104 1.02 0.52 3.84 8.32 8.32 8.32 8.32	PARAMETER CNBUCTVY, FIELD HICROMHOS ALUMINUM, BISS (HG/L-AL) SILVER, DISS (HG/L AS AG) BORON , DISS (HG/L AS B) CADMIUM, DISS (HG/L AS CD) CHROMIUM, BISS (HG/L-CR) COPPER, DISS (HG/L AS CU) LITHIUM, DISS (HG/L AS LI) HOLYBDENUM, DISS (HG/L-HG) HERCURY, DISS (HG/L AS HG)	VALUE 3329. 243. <.002 .027 .064 .041 .57 <.03
ARSENIC, DISS (UG/L AS AS)	40.5	MERCURY, DISS(UG/L AS HG)	
SELENIUM, DISS (UG/L-SE)	.5	ACIDITY, TOT(HG/L-CACO3)	

REMARKS: WATER IS TURBID - MILKY - BECOMES ORANGE UPON REACHING CREEK \* KATE'S COULEE AT MINE ADIT (SITE AS-04) \* ABOVE OLSON HOUSE \* SAMPLE TAKEN AT TOP POOL OUTSIDE ADIT - FLOW JUST BELOW \* LAB: Hf=9.1 MG/L, SIGMA 5.54, TOTAL CATION MERVS/L 52 \*

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATER, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

RW WASE WE OW BU AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 04-MAY-81 BY: TF \*CLC
PROCESSING PROGRAM: F1730F V2 (11/3/81) FRINTED: 27-MAY-83

PERCENT MED/L (FOR PIPER PLOT)
CA MG NA K CL S04 HC03 C03
41.4 53.1 5.0 0.5 0.2 77.8 0.0 0.0

NOTE: IN CORRESPONDENCE; PLEASE REFER TO LAB NUMBER: 8002319

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STATE MONIANA COUNTY CASCADE

LATITUDE-LONGITUDE 47023'34'N 111010'43'N SITE LOCATION 19N AF 14 DOCD

UTH COORDINATES 710 N5218600 E486505 HBMG SITE AS 04

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION ID 4723341'1104301

GEOLOGIC SOURCE 771MRSN* * SAMPLE SOURCE MINE DRAINAGE

DRAINAGE RASIN BE LAND SURFACE ALTITUDE 3560. FY 50

AGENCY + SAMPLER HBMG*JUD SUSTAINED YIELD

DOTTLE NUMBER AS 04 YIELD HAS HETHOD

BATE SAMPLED 03: MAR B1 TOTAL PEPTH OF WELL

TIME SAMPLED 00:30 HOURS SWI AROVE() OR BELOW OS

LAB + ANALYST HBMG*FNA CASING DIAMETER

DATE ANALYZED 72 APR-81 CASING TYPE

SAMPLE HANDING 4120 COMPLETION TYPE *
                                                                            72 AFR-01
4120
GRAB
                      METHOD SAMPLED
                                                                                                                                                 PERFORATION INTERVAL
                                      WATER USE
                                                                            UNUSED
                         SAMPLING SITE STOCKETT - SAND COULEE HINING DISTRICT
                  SECUDIC SOURCE MORRISON FORMATION
                                                                                HG/L
                                                                                                               MEG/L
                                                                                                                                                                                                                                mG/I
                                                                                                                                                                                                                                                         HEGZL
                                                                                167.
                                                                                                                  8.43 BICARBONATE
                                                                                                                                                                                            (RCO3)
              CALCIUM
                                                  (CA)
              HAGNESIUM (MG)
                                                                                 130.
                                                                                                                     11.35 CARRONATE
                                                                                                                                                                                              (003)
                                                                                 22.6
4.7
                                                                                                                  0.98 CHLORIDE
                                                                                                                                                                                                                                                                  0.15
27.00
               SOLIUM
                                                  (NA)
                                                                                                                                                                                                                                         5.3
                                                                                                                                                                                                   (CL)
                                                                                                                                                                                                                             3222.
                                                                                                                    0.12 SULFATE
25.03 NITRATE
                                                                                                                                                                                                 (SC4)
               POTASSIUM
                                                   (K)
                                                                                433:
1.59
51.2
                                                 (FC)
                                                                                                                                                                                                                                                                  0.06
               IRON
                                                                                                                                                                                              (AS N)
              MANGANESE (HN)
SILICA (SIG2)
                                                                                                                       0.03 FLUORIDE
                                                                                                                                                                                                                                         3.02
                                                                                                                                                                                                       (F)
                                                                                                                                                                                                                                                                      0.16
                                                                                                                                          PROSPRATE TOT (AS P)
                      TOTAL CATIONS
                                                                                                                     45.98
                                                                                                                                                                       TOTAL ANIONS
                                                                                                                                                                                                                                                                  67.45
                      STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                                                                                                      (SIGHA)
                                                                                                                        3.00 TOTAL HARDNESS AS CACGS
11.0 C TOTAL ALKALINITY AS CACGS
SODIUM ADSORPTION RATIO
RYTHAR STABILITY INDEX
                                                                                                                                                                                                                                                     220.00
                                                           LABORATORY PH
       FILE WATER TEMPERATURE CALCULATED BISSOLVED SOLIDS SULTES SUBSILIUENT
                                                                                                                                                                                                                                                               0.31
   SUM OF BISS. CONSTITUENT
LAB SPEC.COND.(MICROMHOS/CM)
                                                                                                            3573.
                                                                                                                                            LANGLIER SATURATION INDEX
                                                                                                                                           PARAMETER
CNBUCTVY/FIELD MICROMHOS
ALUMINUM/TR (MG/L AS AL)
TOT/MG/L-CACO3)
                         PARAMETER
                                                                                                         VALUE
                                                                                                                                                                                                                                                      VALUE
                                                                                                         6. C
3.78
TEMPERATURE, AIR (C)
                                                                                                                                                                                                                                                    4105.
                                                                                                                                                                                                                                                  453.
FIELD PH
TRUE FM
IRON, TR (HG/L AS FE)
ARSENIC, TR (UG/L AS AS)
ALUMINUM, DISS (HG/L-AL)
SILVER, DISS (HG/L AS AG)
DORON , DISS (HG/L AS A)
CADMIUM, DISS (HG/L AS CD)
                                                                                                            1.56
                                                                                                                                              ACIDITY, TOT (MG/L -CACO3)
                                                                                                                                                                                                                                               2315.
                                                                                                                                             ACIBITY, TOT (MGZL -CACO3)
SELENIUM, TR (UGZL AS SE)
NICKEL, DISS (MGZL AS NI)
LEAD, DISS (MGZL AS PB)
STRONTIUM, DISS (MGZL AS TI)
TITANIUM DIS(MGZL AS TI)
VANADIUM, DISS (MGZL AS V)
ZINC, DISS (MGZL AS ZN)
ZIRCONIUM DISS(MGZL AS ZR)
ARSENIO, DISS(MGZL AS ZR)
                                                                                                         41.1
                                                                                                                                                                                                                                                         2.12
2.04
1.15
1.04
                                                                                                      248.
                                                                                                      023
                                                                                                               .24
CHROMIUH, DISS (HOZL-CR)
COPPER, DISS (HGZL AS CU)
LITHIUH, DISS (HGZL AS LI)
HOLYBDENUM, DISS (HGZL-HO)
                                                                                                                .067
                                                                                                                                                                                                                                                         3,17
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                                                                                                                                                                                                                                                              .050
                                                                                                                                                                                                                                                       39.0
                                                                                                                .17
                                                                                                                                              ARSENIC, DISS(UG/L AS AS)
 SELENIUM, DISS (UG/L-SE)
REMARKS: SAMPLE CLEAR - LITTLE FILTERATE *

SAMPLE TAKEN AT HINE ADIT ABOVE J. OLSON HOME *

COLD WATER UPSTREAM S.C.=1266 DOWNSTREAM 3818 *

LAB: 67.1 CATION MERVS..15 SIGMA, 32.9 MG/L EST HE *
                                                  MGZU = HILLIGRAMS PER LITER, UGZU = HICROGRAMS PER LITER, HCGZU |
HILLIEGUIVELENTS PER LITER. FT = FEET, HI = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.
                                                                                                                 $2
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                                                                                                                                                                           AT
                                                                                                                                                                                                        OTHER
OTHER AVAILABLE DATA OTHER FILE NUMBERS:
                                                                                                                                                                       COST:
                                        PROJECT:
LAST EDIT BATE: 22-APR-81
PROCESSING PROGRAM: F1730F V2 (11/3/81)
                                                                                                                                                                                                          *CLC
                                                                                                                                                                               BY:
                                                                                                                                                            PRINTED:
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CA HG NA K CL 504 HC03 C03

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8100058

PERCENT HEAZL (FOR PIPER PLOT)

## WATER GUALITY ANALYSIS LAB NO. 8181087

```
MONTANA
                                                                                                               COUNTY CASCADE
                                           47023'34'N 111D10'46'W SITE LOCATION 17N 04E 14 DDCD
712 NS248670 E486570 HBHG SITE AS04
SOUTHEAST GREAT FALLS 7 1 STATION ID 472334111104601
221HRSN* * SAMPLE SOURCE MINE DRAINAGE
    LATITUDE-LONGITUDE
                                                                                # SAMPLE SOURCE MINE DRAINAGE

* SAMPLE SOURCE MINE DRAINAGE
LAND SURFACE ALTITUDE 3540, FT < 50
SUSTAINED YIELD
YIELD HEAS METHOD
          UTM COORDINATES
           TOPOGRAPHIC HAP
          GEOLOGIC SOURCE
DRAINAGE BASIN
GENCY | SAMPLER
BOTTLE NUMBER
                                           BR
        AGENCY 3
                                           HEHS*ABH
                                           AS04
                DATE SAMPLED
                                                                          TOTAL BEFTH OF WELL
SWL AROVE(-) OR BELOW OS
CASING DIAMETER
                                           15-JUL-81
14:00 HOURS
HEHG*FNA
          LAB & ANALYST MAMO*
DATE ANALYST MAMO*
DATE ANALYST MAMO*
CAMPLE BANDLING 4220
METHOD SAMPLED GRAB
                                                                                                                 ֓֟֓֓֓֟֓֓֓֓֓֟֓֓֓֓֓֓֟֓֓֟֓֓֟֓֟֓֟
מַמִּצְינ
                                                                                            CASING COMPLETION
                                                                                  PERFORATION INTERVAL
                      WATER USE
                                          UNUSED
          SAMPLING SITE SAND COULEE HINING DISTRICT*NO-NAME CREEK SEGLOGIC SOURCE MORRISON FORMATION
                                                                HER/L
                                                                                                                                HGZL.
                                                                                                                                                MER/L
                                             MG/L
                                                                                                           (E03)
                                                                                                                                     . 0
        CALCIUM
                            (CA)
                                                                    8.03 BICARBONATE
                                             131.
                                             1(8)
17.7
        HAGNESIUM (MG)
                                                                    5.71
0.77
                                                                              CARBONATE
                                                                                                                                      .0
                                                                                                                                                  0.26
60.75
0.02
0.19
                                                                              CHLORIDE
SULFATE
NITRATE
                                                                                                                              2916.
- 32
                                                                                                                                    7.1
        SORTUH
                                                                                                               (CL)
                            (NA)
        POTASSIUM
                            (K)
                                                                    0.04
                                                                                                             ($04)
         IRON
                                              568.
                                                                  30.51
                                                                                                            (AS 10)
        HANGANESE (HN)
                                                ິ2.00
໒2.1
                                                                   0.02 FLUORIDE
                                                                                                                                    3.57
                                                                                                                 (F)
        SILICA (SIG2)
                                                                              PROSPRATE TOT (AS P)
            TOTAL CATIONS
                                                                  45.14
                                                                                               TOTAL ANIONS
                                                                                                                                                  61.22
            STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                         (SIGHA)
                                 LABORATORY PH
                                                                      3.63
                                                                                      TOTAL HARDNESS AS CACOS
                                                                                                                                            887.71
    FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
                                                                                 TOTAL ALKALINITY AS CACOS
SOBJUH ASSORPTION RATIO
RYZNAR STABILITY INSEX
LANGLIER SATURATION INDEX
                                                                    13.7
                                                                                                                                                0.26
  LAB SPEC.COND. (HJCROHHOS/CH)
                                                               3337.
                                                           VALUE
22. C
3.85
3.27
<.04
                                                                                                                                           VALUE
                                                                                               PARAMETER
              PARAMETER
                                                                               PARAMETER
CNDUCTVY,FIELD HICROMHOS
ALUMINUM, BISS (MG/L-AL)
SILVER,DISS (MG/L AS AC)
BORON DISS (MG/L AS B)
CABMIUM,DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CU)
COPPER,BISS (MG/L AS CU)
LITHIUM,DISS (MG/L AS CU)
HOLYEDENUM,DISS (MB/L-MB)
                                                                                                                                          3284.
TEMPERATURE, AIR (C)
FIELD PH
                                                                                                                                           346.
FIELD PH
NICKEL-DISS (MG/L AS NI)
LEAD+DISS (MG/L AS PB)
STRONTIUM+DISS (MG/L AS TI)
TITANIUM DISS(MG/L AS TI)
VANADIUM+DISS(MG/L AS V)
ZINC+DISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR
IRON+TR (MG/L AS FE)
                                                                                                                                              .002
.25
.074
                                                               .030
                                                                                                                                                .28
                                                               . 15
                                                                                                                                              <.02
                                                            13.6
                                                         577.
                                                                                HOLYBDENURADISS (MSZL-MO)
                                                                                SELENTUH, TR (UG/L AS SE)
ACIDITY, TOT (HG/L-CACO3)
                                                                                                                                              3.1
```

REHARNS: WATER CLEAR BUT GASSY UPON FILTRATION
KATE'S COULEE AT MINE ADIT \* SITE AS-04 \* ABOVE OLSON HOUSE \*
SAMPLE FROM ABIT MOUTH
LAB: H- 39.63 MG/L GIVES 57.9 MER CATIONS GIVES 3.3 SIGNA

ALUMINUM, TR (MG/L AG AL)

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L HILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL.

UL 02 IJ T OW 3244 47 RITHER WA

348.

OTHER AVAILABLE DATA OTHER FILE NUMBERS: 8100050 8002319

COST: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: EY: TP \*JKS 19-FEB 82 - Řízdoř Vá 27-HAY-83 (11/3/31) PRINTED:

> PERCENT MERZE (FOR PIPER PLOT) NA CA MG 43.3 52.3 . K \$04 HC03 99.6 0.0 CU 033 0. 4.2 0.4

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8101087

1970.

WATER QUALITY ANALYSIS LAR NO. DOCCED

STATE MONTANA COUNTY CASCADE

SITURE 47823/34\*N 111810/37\*W SITE LOCATION 19N 48 14 8880
ENATES ZLO NSC10570 C408620 MAMG SITE AS 65
EC MAP SOUTHEAST GREAT FALLS 7 1 STATION IN 1223341:110370:
SOURCE 228MRSN\* \* \* SABELE SOURCE STREAM
BASIN BE LAND SURFACE ALTIBUT 3510, ET 1
WATER LIUW NATE 50. UPM
4MPLER HRMS\*JJD WATER LIUW NATE 50. UPM
4MPLER AS 05 FLOW MEAS METHOD FSTUMATER
AMPLED 20-SIP GO SIRCE ABOUT LATTIUNE - LONGITURE UTH COORDINATES TOPOGRAPHIC HAP TOPOGRAPHIC MAP SOUTHEAST OF SCOLOGIC SOURCE 221MRON#
DRAINAGE BASIN PR
AGENCY + SAMPLER HRMG\*JJD
BOITLE NUMBER AS 05
DATE SAMPLED 20-SEP 60
TIME SAMPLED 12:00 HOURS
LAR + ANALYST MRNG\*ENA
DATE ANALYST HRNG\*ENA
SAMPLE HANDLING 5120
HETHOU SAMPLED SEAR 1.0

WATER USE UNUSED

METHOD SAMPLED GRAD

SAMPLING SITE SAND COBLET MINING BUSTRICT\*NO NAME CREEK BRAINAGE BASIN MISSOURI RIVER RETWEEN MARIAS RIVER AND LITTLE PRICELY PE.

CALCIUM (CA)	MO/1 167∙	MEG/L 8.43	BICARBONATE	(BC03)	#87L	MERZI.
HAGNESTUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE)	141. 23.9 4.6 380.	J.04 0.12 20.41	MITRATE	(003) (01) (004) (AS N)	3150. .03	0.17 35.58
MANGANESE (MN) SILICA (SID2)	1.63 58.0	0.08	FLUDRIDE PROSPRATE TOL	(AS P)	3 25	0.17
TOTAL CATIONS		41.66	TOTAL	ANIONS		65.92

STANDARD DEVIATION OF AMION CACTON RALANCE (SISMA)

2.87 LARGRATORY PH TOTAL HARDNESS AS CACOS 1002.35 CIELD WATER LEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 14.1 C FOTAL ALKALINITY AS CACOJ SOBTUM ABSORPTION RATIO RYZNAR STABILITY INDEX LANGLIER SATURATION INDEX 0.33 SPEC.COND. (MICROHHOS/CM) 3566.

PARAMETER	75F BE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	15.0 €	CNDUCTVY/FIELD MICROMNOS	3352.
CIELD PR	3,42	ALUMINUM, DISC (MS/L AL)	742.
NICKEL-DISS (MG/L AS NI)	2.08	SILVER: DISS (MS/L AS AS)	.002
LEAD-RISS (MS/L AS PR)	< 5.0.4	BORON → DISS (HS/L AS D)	.16
STRONTIUM,DISS (MS/L-SR)	1.08	CADHTUM/DISS(MB/L AS CD)	.033
TITANTUH DIS(MG/L AG TI)	.040	CHRONIUM, DISC (MS/L CR)	.040
VANADIUH, DISS(HS/L AS V)	.034	COPPER•DISS (MOZE AS CH)	.016
ZINC>DISS (MG/L AS ZN)	৪.3১	LITHIUM, DISS(MS/L AS LI)	.55
ZIRCONIUM DISCHOZE AS ZR	.025	MOLYBRENUM, RISS(MG/L MO)	02
ARSENIC: BISS(US/L AS AS)	7.5	MERCURY→DISS(US/L AS HS)	, 23
SELENIUM, DISS (UG/L-SE)	<.3	ACIDITY, TOT(MG/L-CAC03)	2262.

REMARKS: WATER IS BRIGHT GRANGE | BECOMES BEER RED UPON REACHING CREEK \* CAMPLE TAKEN AT CONFLUENCE OF KATE'S CREEK WITH NO NAME CREEK FROM KATE'S CREEK WITH NO NAME CREEK FROM KATE'S CREEK \* SUNER REPORTS RAIN CAUSES WHITE PRECIPITATE \* LAB: H4=15.9 MOZL \* 15.8 MERVSZL, SIGMA - .46, 66.4 TOTAL CATION MERVSZL \*

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L : HILLTEDUTVELENTS PER LITER. FT = FEFT, HI = METERS. (H) = HEASURED, (E) = ESTIMATER, (R) = REPORTED. IR = TOTAL RECOVERABLE. TOT = TOTAL.

> ∩₩ F.IA UH MA IJ I 43

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: PROCESSING PROGRAM: 04 MAY 81 F1730F V2 (11/3/01) RY: ID #CLC 27 MAY 83 PRINTEUT

> PERCENT MEGAL (FOR PIPER PLOT) MG Ŋ OL 504 0.3 22.7 CA NA 004 H003 003 37.8 54.7 0.5 0.0

NOTE: - IN CORRESPONDENCE, PLEASE RIFLE TO LAB NUMBER: 8000300

#### WATER QUALITY ANALYSIS LAB NO. 8180057

HONTANA COUNTY CASCADE STATE 47D23'33'N 111D10'38'W 7J2 N5248605 C486605 SOUTHEAST GREAT FALLS 7 1 SITE LOCATION 17N 4E 14 DDDC HRMG SITE AS-05 STATION 1D 472333111103801 SANCLE SOURCE STREAM LATITUDE-LONGITUDE HRMG SITE
STATION ID
IPLE SOURCE
E ALTITUDE
FLOW RATE UTH COORDINATES TUPOGRAPHIC MAP MAF GEOLOGIC SOURCE DRAINAGE BASIN \* \* \* 3510. 150. LAND SURFACE FT < 1 BRAIRAGE SABLE AGENCY & SAMPLER BOTTLE NUMBER DATE SAMPLED TIME SAMPLED WATER ÜLU\*∂HÄH GPH FLOW HEAS HETHOD ESTIMATED AS-05 STAFE GAGE STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM 03-HAR-81 09:00 HOURS LAR F ANALYST DATE ANALYZED SAMPLE HANDLING MBMG\*FNA

WATER USE UNUSED

HETHOD SAMPLED GRAD

22-AFR-81 4120

SAMPLING SITE STOCKETT - SAMP COULER MINING DISTRICT DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY

CALCIUM (CA)	HB∠L 22.0	MEQ/L	BICARBONATE	(8033)	MGZI.	HER/L
MAGNÉSIUM (MG) SODIUM (NA)	79.4 12.8	6.53	CARBONATE CHLORIBE	(503)	.5 . 4	0.18
POTASSIUM (K) IRON (FE)	3.4 186.	9,55	SULFATE NITRATE	(SO4) (AS N)	2854. ,.09	57.42
MANGANESE (MN) STLICA (SIG2)	.98 30.6	0.04	PROSPRATE TOT	(F) (AS P)	2.63	0 ( 14
TOTAL CATIONS		22.14	TOTAL	ANIONS		59.75

STANDARD REVIATION OF ANION-CATION RALANCE (SIGMA)

TOTAL HARBNESS AS CACO3
TOTAL ALKALINITY AS CACO3
SOBJUM ABSORPTION RATIO
RYYNAR STABLLITY INDEX LARGRATORY PH 2.89 574.01 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 46.000 0.23 SPEC.COND. (MICROMHOS/CH) LANGLIER SATURATION 3317. INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	8. C	CNDUCTVY, FIELD MICROMHOS	3426.
FIELD FO	3.39	ALUMINUH, TR (MG/L AS AL)	127.
IRON:TR (MG/L AS FE)	192.	ACIDITY, TOT (MO/L-DACOS)	2250.
ARSENIC,TR (UG/L AS AS)	14.4	SELENIUM, TR (UB/L AS SE)	. 4
ALUHINUH, DISS (MG/L-AL)	124.	NICKEL/DISS (MG/L AS NI)	1.22
SILVER-DISS (MG/L AS AS)	• 05	LEAD, DISS (MG/L AS PR)	, 13
DORON FRISS (MOZE AS B)	•17	STRONTIUM,DISS (MG/L-SR)	1624
CADMIUM,DISS(M6/L AS CD)	.034	TITANIUM DIS(MG/L AS TI)	.025
CHROMIUH + DISS (MO/L+CR)	.063	VANADIUH, DISS(NGZL AS V)	.071
- COPPER•DIGS (MG/4 - AS CU)	.050	ZINC,DISS (MG/L AS ZN)	4,47
LITHIUM, DISS(MG/L AS LI)	.305	ZIRCONIUM DISCHGZU AS ZR	, 085
MOLYBRENUM+DISS(MG/L~MO)	.57	ARSENIC+DISS(UG/L AS AS)	14.4
SELENIUM+ BIOS (UG/L SE)	.3		

REMARKS: WATER IS GRANGE - TURBID \* FE-HYDROXIDE PRECIPITATE \* SAMPLE FROM BELOW CULVERT ABOVE JUNCTION WITH STRAIGHT CREEK \*
STREAM BRAINAGE FROM ACID SPRING AS-04 \* UPSTREAM S.C. 5192 BOWN 41)
57.9 CATION MEGYS. 195 SIGMA, 42.6 MG/L EST HE \*

EXPLANATION: MG/L = MILLIGRAMS PER LITER. UG/L = MICROGRAMS PER LITER. HEQ/L MILLIERUIVELENIS PER LITER. ET = FEFT, MT = HETERS. (M) = MEASURED. (E) = TOT = TOTAL. = REPORTED. TR = TOTAL (R) RECOVERABLE. ESTIMATED.

> 52 (I) W WA UI C₩ FU ΔT OTHER

ATAC SUBALIAVA REHTO OTHER FILE NUMBERS:

: PROJECT: LAST FRIT BATE: COST: 29-APR 81 TP \*CLG BY: F1730F V2 (11/3/81) PROCESSING PROGRAM: 27-HAY 83 PRINTEDI

> PERCENT MEDIL (FOR PIPER PLOT) CA C1. S04 S04 HC03 mG NA 003 40.8 53.9 4.5 0.0 0.0

```
STAIE MONIANA COUNTY CASCABE
LATITUDE-LONGITURE 47023/59*N LLIDLO/LO*W SUTE LOCATION 19N 15 L3 CABR
UTH COORDINATES 712 N5219350 E487195 HRNG SUTE AS 06
TOPOGRAPHIC MAP SOUTHFAST GREAT FALLS 7 L STATION IN 1723591L110L001
GFOLOGIC SOURCE 22 LMRSN*111SPRN* * SAMPLE SOURCE MINE DRAINAGE
DRAINAGE BASIN BR LAND SURFACE ALTITURE 3500. FT 50
              ATTITUDE -- LONGITUDE 47B23/59*N 111

UTH COURBINATES 712 N5249350 E
TOPOGRAPHIC MAP SOUTHFAST GRE/
GEOLOGIC SOURCE 2/UMRSN*111SP/
DRAINAGE BASIN HR
ASENCY + SAMPLER MRMS*JUD
BOTTLE NUMBER AS-06

DATE SAMPLED 16:00 HOURS
LAR + ANALYZED 16:FEH-BL
SAMPLE HANDLING 4170
HETHOD SAMPLED GRAH
                                                                                                                                                                        SUSTAINED YILLD
                                                                                                                                     SUBTRIBUTE THE SUBTRIBUTE OF THE SUBTRIBUTE OF THE SUBTRIBUTION OF SUBTRIBUTE OF THE SUBTRIBUTE OF THE
                      METHOD SAMPLED GRAS
                                                                                                                                                    PERFORATION INTERVAL
                                                                            UNUSED
                                         WATER USE
                   SAMPLING SITE SAND COULFE MINING DISTRICT*NO NAME CREED SCOLOSIC SOURCE MORRISON FORMATION
                                                                                                                                                                                                                                       #874 #EQ74
                                                                                                                    MEG/1
                                                                                  MG/L
                                                                                     88.0
88.0
18.7
                                                                                                                          3.09 BICARBONALE
7.31 CARBONATE
0.79 CHLORIBE
0.06 SULFATE
              CALCIUM
                                                   (CA)
                                                                                                                                                                                                   (RC03)
              MAGNESIUM (MG)
                                                                                                                                                                                                   (003)
                                                                                                                                                                                                                                                                         0.21
                รอกมีบัส
                                                                                                                                                                                                         (CL)
                                                                                                                                                                                                                                                7.5
                                                     (NA)
                                                                                                                                               SULFATE
                                                                                                                                                                                                                                     1060.
               POTASSIUM
                                                                                                                                                                                                     (SG4)
                                                     (K)
                                                                                                                                                                                                                                      2.40
                                                                                                                           3.98 NITRATE
                                                                                       74.1
                                                   (FE)
                                                                                                                                                                                                   (AS N)
               IRON
                                                 (HH)
               MANGANESE
                                                                                        1.07
                                                                                                                           0.04 FLUORIDE
                                                                                                                                                                                                           (5)
                                                                                                                                                                                                                                                                           0.13
                SILICA (SIO2)
                                                                                                                                              PROSPRATE TOT (AS P)
                                                                                       50.5
                      TOTAL CATIONS
                                                                                                                        15.27
                                                                                                                                                                            TOTAL ANTONS
                                                                                                                                                                                                                                                                          22.41
                       STANDARD DEVIATION OF ANION-CATION RALANCE (CIGMA)
                                                                                                                          2.97 TOTAL HARDNESS AS CACGS
10.4 C TOTAL ALKALINITY AS CACGS
SOUTUM ADSCRITTON RATIO
RYTNAR STABILITY INDEX
108. LANGLIER SATURATION INDEX
                                                           LARGRATORY PH
                                                                                                                                                                                                                                                             520.31
                     FIELD WATER TEMPERATURE
   CALCULATER DISSOLVER SOLIDS
SUM OF DISS. CONSTITUENT
LAB SEC.COND.(MICROMHOS/CM) 1808.
                                                                                                                                                                                                                                                                     0.35
                                                                                                            VALUE
                                                                                                                                                                                                                                                             VALUE
                           PARAMETER
                                                                                                                                                                           PARAMETER
                                                                                                                                               PARAMETER
CNDUCTVY, FIELD H (CROMHOS
ALUMINUM, DISS (MG/L AL)
SILVER, DISS (MG/L AS AG)
BURON , DISS (MS/L AS B)
CADMIUM, DISS (MS/L AS CD)
CHROMIUM, DISS (MS/L AS CU)
LITHIUM, DISS (MS/L AS CU)
LITHIUM, DISS (MS/L AS CU)
                                                                                                            13.0 C
3.02
 TEMPERATURE, ATR (C)
                                                                                                                                                                                                                                                           1701.
ETELD OIL
                                                                                                                                                                                                                                                             50.0
HICKELIBIOS (MB/L AS NI)
LEADIDISS (MB/L AS PB)
STRONTIUMIDISS (MB/L SR)
TITANIUMIDISS (MB/L AS TI)
VANADIUMIDISS (MB/L AS V)
                                                                                                            .42
                                                                                                                                                                                                                                                               002
                                                                                                        1.024
1.034
1.027
1.027
                                                                                                                                                                                                                                                                    .011
VANADIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS (MG/L AS ZR
ARSENIC, DISS (UG/L AS AS)
SELENIUM, DISS (UG/L SE)
                                                                                                                                                                                                                                                               .35
                                                                                                                                                 HOLYEDENUM, ELSS (HGZL -KD)
HERCURY, DISS (UGZL AS HS)
                                                                                                               <.004
                                                                                                            16.7
                                                                                                                                                  ACIDITY, TOT (MG/L CACO3)
                                                                                                                  . 3
REMARKS: SAMPLE CLEAR - NO PRECIPITATE *
                                  SPRING DISCHARGES FROM WITHIN SPOIL FILE IN FRONT OF ABIT *
              ADIT APPEARS DRY * LAB: HF=5.0 MG/L * 4.9 MEQVS/L, SIGMA .09, 22.5 TOTAL CATION HEQVS/L *
EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L = MILLIEQUIVELENTS PER LITER. ET = FEET, MT = METERS. (M) = MEASURED; (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.
                                                                                      QW
                                                                                                                   52
                                                                                                                                   WI.
                                                                                                                                                  \Omega \square
                                                                                                                                                                PIR
                                                                                                                                                                               AT
                                                                                                                                                                                                             DITHER
                                                                                                     MA
```

COST:

PRINTERS

BY:

TF #CLC 27 HAY 83

DERCENT MEGAL (FOR PIPER PLOT) CA MG CL 584 HC03 NA . 003 7.0 27,5 34,9 0.5 1.0 77.0 0.0 0.0

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

CROCESSING PROCESSING

TROJECT:

NOTE: IN CORRESPONDENCE: PLEASE REFER TO LAB NUMBER: 0000301

04 MAY 81 F1730P V2 (11/3/81)

STATE MONTANA

#### - WATER QUALITY ANALYSIS LAB NO. BOR2322

COUNTY CASCADE

```
MONTANA
47B23'48"N 11B10'20"W SITE LOCATION
Z12 N5249020 E488980 HRMG SITE
SOUTHEAST GREAT FALLS 7 1 STATION IB
CZIMRSN*L11SPRN* * SAMPLE GOURCE
RB LAND SURFACE ALTITUDE
MBMG*JJD SUSTAINED YIELD
                                                                                                                                             190 4E 13 CEBC
45-07
472348111102001
MINE DRAINAGE
3520, FT < 50
     LATITUDE-LONGITUDE
            UTH COORDINATES TOPOGRAPHIC HAP
            GEGLOGIC SOURCE 22
DRAINAGE BASIN BE
           DUTILE NUMBER AS-07
BATE SAMPLED 20-SEP-80
TIME SAMPLED 17:00 HOURS
LAB + ANALYST MBMG*FNA
DATE ANALYZED 18 FEE-81
CAMPLE NAMBLING 1120
HETHOD SAMPLES
          AGENCY + SAMPLER
BOTTLE NUMBER
                                                                                                    YIELD MEAS HETHOD
                                                                                            TILLE MEAS METHOD TOTAL DEPTH OF WELL ABOVE(-) OR BELOW GS CASING BIAMETER CASING TYPE COMPLETION TYPE PERFORATION INTERVAL
                          WATER USE
                                                UNUSED
           SAMPLING SITE SAND COULEE MINING DISTRICT*NO-NAME CREEK GROUDSIC SOURCE HORRISON FORMATION
                                                   MG/1.
                                                                        MCG/L
                                                                                                                                                HG/L
                                                                                                                                                                  ME Q/L
                                                                                                                         (E003)
         CALCIUM
                                (CA)
                                                   188.
                                                                             9.38 BICARBONATE
                                                   180.
         MAGNESIUM (MG)
                                                                           14.81 CARBONATE
                                                                          0.79 CHLÖRIBE
0.02 SULFATE
53.73 NITRATE
                                                                                                                           (CL)
(SO4)
                                                                                                                                                     4,1
                                                                                                                                                                  0,12
165.31
0,00
          SODIUM
                                 (NA)
                                                                                                                                             7540(=
.07
7.2
                                 (K)
         POTASSIUM
                                                       . 6
                                                 1004.
          IRON
                                                                                                                         (AS N)
         MANGANESE (MN)
                                                 4.45
                                                                           0.13 FLUORIDE
                                                                                                                               (F)
                                                                                                                                                                       0.38
          SILICA (SIGE)
                                                   138.0
                                                                                        PHOSPHATE TOT (AS P)
              TOTAL CATIONS
                                                                          75.05
                                                                                                           TOTAL ANIGNS
                                                                                                                                                                   145.81
              STANDARD DEVIATION OF AHION CATION BALANCE
                                                                                                                     (SIGMA)
                                                                             2.55 TOTAL HARDNESS AS CACOS
19.9 C TOTAL ALKALINITY AS CACOS
CODIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
38. LANGLIER CATURATION INDEX
                                     LAMORATORY PH
                                                                                                                                                           1210,32
  FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISSOLVED TUENT LAB OFFO.COND.(MICROBHOS/CH)
                                                                                                                                                                   0.23
                                                                       6238.
                PARAMETER
                                                                   VALUE
                                                                                                           PARAMETER
                                                                                                                                                             VALUE
                                                                                         PARAMETER
ENDUCTVY, FIELD MICROMHOS
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AB)
BORON , DISS (MG/L AS B)
CABMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS CU)
MICROMICH, DISS (MG/L AS CU)
ACIDITY, TOT (MG/L ACADS)
                                                                   13.0 C
TEMPERATURE, AIR (C)
                                                                                                                                                            3362.
FIELD PH
                                                                                                                                                            580.
FIELE PH

NICKEL, DISS (MG/L AS NI)

LEAD, DISS (MG/L AS PB)

STRONTIUM, DISS (MG/L AS TI)

VANADIUM, DISS (MG/L AS TI)

VANADIUM, DISS (MG/L AS ZN)

ZINC, DISS (MG/L AS ZN)

ZIRCONIUM DISS (MG/L AS ZR

ARSENIUM, DISS (MG/L AS AS)

SELENIUM, DISS (MG/L SE)
                                                                      3.50
                                                                                                                                                                  .007
                                                                      1.04
1.16
                                                                                                                                                                  310
                                                                                                                                                                  .034
.27
.37
                                                                      .050
                                                                                                                                                                  . 62
                                                                   13.3
                                                                       .065
                                                                    77.3
                                                                                                                                                                   .04
 SELENIUM, DISS (UGZE SE)
                                                                                           ACTRITY, TOT (MG/L -CACG3)
                                                                                                                                                         5195.
REMARKS: CLEAR WATER - NO PRECIPITATE *
                    SPRING RISES FROM WITHIN SPOIL FILE JUST SW OF HINE ABIT " SOUTH OF SAND COULEE * FRICKLE FROM ABIT BISCHARSE * IN = 28.1 MO/L * 27.5 MERVS/L * SIGMA 15.5, 128.8 TOTAL CATION MERVS/L
```

EXPLANATION: HG/L = HILLIGRANS PER LITER. UG/L = MICROGRAMS PER LITER, HCG/L HILLIEGUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED. (E) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

F.M 04  $M\Lambda$ 13.1 ೧ಟ AT DIBLER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST FRIT BALL: 08 MAY 01 BY: TP #CLC PROCESSING PROGRAM: E1730P V2 27 HAY-83 (11/3/01) PRINTED:

> PERCENT MEGAL (FOR DIFFR PLOT) CA HO. 3 , 2 0.1 003 37,5 50,5 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFLE TO LAR NUMBER: 8002322

WATER GUALITY ANALYSIS LAR NO. BORRSET

STAFE MONTANA
STUDE 47018/47\*N 111011/09\*N
NATES 712 N5239770 E465940
C MAP SPRING COULEF 7 1/2/
SOURCE 271MRSN# # CASCADE COUNTY COUNTY SASCABL

(09\*W SITE LOCATION 18N 4F 14 ALCO

ABMG SITE BG 01

STATION 18 42:6477:11:10201

SAMPLE SOURCE MINE BRAINAGE
LAND SURFACE ALTIUDE 3860, FT 10

SUSTAINED YIELD

YIELD MEAS METHOD

TOTAL DEPUT OF WELL

ABOVE(-) OR BELOW GS

CASIMG BIARCTER THE COURTINATES TOPOGRAPHIC MAP TOPOGRAPHIC MAP SPRIM
GEOLOGIC SOURCE COLMI
DRAINAGE BASIN BE
ASENCY + SAMPLER MEMOR
BOTTLE NUMBER ES OF
DATE SAMPLED 15:00
LAB + ANALYST MEMOR
BATE ANALYST MEMOR
BATE ANALYST MEMOR
BATE ANALYST GEORE BBBG\*JJD RS 01 20 SEP 50 15:00 HOURS CASING DIAMETER CASING TYPE COMPLETION TYPE ก≱ทธ\*กNA 18-FEB-81 METHOD SAMPLED GRAD PERFORATION INTERVAL WAISE USE UNUSED

SAMPLING SITE SAND COULFF MINING DISTRICT\*NO FIVE CREEK GOOLOGIC SOURCE MORRISON FORMATION

CALCIUM (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (N) IRON (FC) MANGANESE (MN) SILICA (SIO2)	#6/L 101. 41.57 50.55 20.55	3.42 0.35 0.15 3.35	BICARBONATE CARBONATE CHLORIDE SULFATE NITRATE ELUORIDE PHOSPHALE TOT	(AS N) (E)	#6/L 5:5 5:0 1:05	0.10 11.41 0.03
TOTAL CATTONS	20.8	13.63		ANIONS		(1,56

STANDARD DEVIATION OF ANION CATION BALANCE (SIGHA)

LABORATORY PH 3.32 TOTAL HARDNESS AS CACOS 173.36 7:2 C TOTAL ALKALINITY AS CACOZ SOBJUN ADSORPTION RATIO RYZNAR STABILITY INDEX FIELD WATER TEMPERATURE CALCULATED DISSOLVED COLIDS 0.30 SPEC.COND. (MICROMHOS/CH) 1205. LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE: AIR (C)	16.0 0	COMMOTOR-FILL HICROPHOS	1122.
FISLD PH	5.41	ALUHINUM: DISS (MG/L-AL)	3.04
NICKEL/DISS (MG/L AS NI)	.30	SILVER/DISS (MO/L AS AS)	0.002
LEAD+DISS (MS/L AS PB)	< . 04	BORON FRISS (MS/L AS B)	.06
STRONTIUM,RISS (MGZL~SR)	.31	CADMIUM, DISS(MGZL AS CD)	.005
TITANIUM DIS(MS/L AS TI)	.013	CHRCHIUM, DISS (MG/L~CR)	.004
VANADIUM, DISS(HG/L AS V)	.005	COPPER, RISS (MS/L AS DU)	.013
ZINC>BISS (MS/L AS ZN)	1.23	LITHIUM>DISS(MG/L AS LI)	.062
ZIRCONIUM DISCHOZE AS ZR	<.004	MOLYBRENUM, RISS (MG/L MO)	₹.02
ARSENIC, DISS(UG/L AS AS)	1.7	HERCURY, DISS(UG/L AS HG)	.04
SELENIUM, DISS (UG/L-SE)	. 3	ACIDITY,TOT(MG/L-CACO3)	108.

REMARKS: WATER TURBID - SLIGHTLY NILKY \* RECOMES PALE TO BRIGHT ORANGE UPON HIXING \* GRIFFEN HINE OUTFLOW ROHOL \* SAMPLE TAKEN FROM OUTFLOW FROM ABIL \* LAB: HE=O MGZL, +2.9 SIGMA, 12.4 TOTAL CATION MERVSZL \*

EXPLANATION: MG/L = MILLIGRANS PER LITER, UG/L = MICROGRANS PER LITER, HEG/L = MILLIFGULVELENTS PER LITER. FT = FEET, HT = METERS. (M) = MEASURED: (E) = ESTIMATED: (R) = REPORTED: TR = LOTAL RECOVERABLE: TOT = TOTAL.

QW WA 52 WI 0.4 F. II OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT LAST EDIT DATE: RY: TO \*CLC 04 HAY-31 PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTERS 27 HAY 83

> PERCENT MODZE (FOR PIPER PLOT) CA HG 58.9 33.4 S04 HC03 HA CI 0.03 K 1.5 0.9 99.1 5.3 0.0 0.0

IN CORRESPONDENCE, PLEASE REFER 30 LAR NUMBER: 8002323 HOTE:

#### WATER QUALITY ANALYSIS LAB NO. 8100000

```
STATE MONTANA
                                          COUNTY CASCADE
    LATITUDE-LONGITÜDE
                                                                                                                                      4E 14 ACCD
          UTH COORDINATES
                                                                                                                             BS-01
           TOPOGRAPHIC MAP
                                                                                                                             471847111110501
MINE DRAINAGE
3840. FT < 10
            EGLOGIC SOURCE
DRAINAGE BASIN
          GEOLOGIC.
        BRAINAUL BABIN BB

AGENCY & SAMPLER HRMG*JJD

BOTTLE NUMBER BS-01

DATE SAMPLED 03-MAR-81

TIME SAMPLED 15:00 HOUL

LAB + ANALYST HRMG*FNA

DATE ANALYZED 22-APR-81

SAMPLE HANDLING 4120

METTON SAMPLED BAB
                                                                         SUSTAINED TREED
YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL AROVE(-) OR RELOW GS
CASING DIAHETER
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                                           METHOD SAMPLED GRAB
                                          UNUSED
                       WATER USE
          SAMPLING SITE STOCKETT " SAND COULEE MINING DISTRICT GEOLOGIC SOURCE HORRISON FORMATION
                                             MG/I.
                                                                HEQZI.
                                                                                                                               MGZI.
                                                                                                                                                MERZE
                                                                    3.23 BICARBONATE
                                               54.7
        CALCIUM
                            (CA)
                                                                                                           (RC03)
                                               07.7
7.7
4.7
29.1
        MAGNESIUM (MG)
                                                                                                            (003)
                                                                                                             (CL)
(S04)
                                                                                                                                                  0.14
         SCRIUM
                            (NA)
                                                                    0.33 CHLORIDE
                                                                                                                                   4.C
                                                                              SULFATE
                                                                    0.11 SULFATE
1.56 NITRATE
                                                                                                                               632.
11
1.23
        POTASSIUM
                               (K)
        IRON
                             (FC)
                                                                                                           (AS N)
                                                                                                                                                    0.01
        MANGANESE (MN)
                                                                    O.O. FLUORIDE
                                                                                                                 (F)
                                                                                                                                                   0.06
        SILICA (SIG2)
                                               10.6
                                                                              PHOSPHATE TOT (AS P)
             TOTAL CATIONS
                                                                    7.05
                                                                                               TOTAL ANIONS
                                                                                                                                                  13.37
            STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                       (SIGMA)
                                                                      3.62 TOTAL HARDNESS AS CACO3
7.9 C TOTAL AUXALINITY AS CACO3
SOBIUM ADSORPTION RATIO
RYZNAR STABILITY INDEX
                                                                                                                                            253.75
                                 LABORATORY PH
  FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND. (MICROMHOS/CM)
                                                                                 SCRIUM ADSCRPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                                                                                                                                0.21
                                                              1984.
PARAMETER (C)
                                                            VALUE
                                                                                                                                            VALUE
                                                                                               PARAMETER
                                                           10. C
5.32
                                                                               CNRUCTVY/FIELD MICROMHOS
ALKALINITY/FLD(AS CACO3)
                                                                                                                                          1038.
                                                                                                                                            30.4
FIELD PH
ALUMINUM, TR (MG/L AS AL)
ACIDITY, TOT (MG/L CACG3)
SELENJUM, TR (UG/L AS SE)
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PR)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS ZN)
ZIRCONIUM BISS (MG/L AS ZR
ARSENIC, DISS (UG/L AS AS)
FIELD PH
                                                                               TRON, TR (HGZE AS FE)
ARSENIC, TR (UGZE AS AS)
ALUMINUM, DISS (HGZE AL)
                                                            1.72
                                                                                                                                            30.2
5.2
1.16
                                                          403.8
                                                         <.1
.24
                                                                                SILVER, DISS (MG/L AS AS)
BORON, DISS (MG/L AS B)
CABMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L CR)
                                                                                                                                             .057
                                                               .05
.170
.012
.055
                                                                                                                                               .14
                                                                                                                                                .040
                                                                                COPPER, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS LI)
MOLYRDENUM, DISS (MG/L-MO)
SELENIUM, DISS (UG/L-SE)
                                                                                                                                               .042
                                                               .600
                                                              6.2
                                                                                                                                              < . 1
```

REMARKS: WATER SLIGHTLY TURBID -- BUT LITTLE ORANGE FILTERATE \* GIFFEN HINE OUTFLOW -- AT ABIT \* LABS 13.7 CATION HEOVS. -.25 SIGMA, 17.2 MG/L EST. H: \*

EXPLANATION: MO/L = MILLIGRAMS FER LITER, MO/L = MICROGRAMS FER LITER, MER/L MILLICQUIVELENTS FER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

NAMED TA WE NO IN SE AN WORD AT ATAC

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST CDIT DATE: 29-APR-81 BY: TP \*CLC
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT HER/L (FOR PIPER PLOT)
CA MG NA N OL SO4 HOO3 CO3
58.5 33.4 6.1 2.0 1.0 97.0 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8100040

WATER GUALITY ANALYSIS LAR NO. 8002324

```
STATE MONIANA
LATITUDE-LONGITUDE 47D18'40'N 111D11'13'W SITE LOCATION 18N 4E 14 CAAD UTH COORDINATES 712 N5237840 F485850 HRMS SITE RS 02 STATION 1D 47184011111301 ** SAMPLE SOURCE SPRING
                                                                                                                                                 *
               GEOLOGIC SOURCE 221MRSN*
DRAINAGE BASIN RB
AGENCY + SAMPLER MRMG*JUD
BOTTLE NUMBER BS-02
                                                                                                                                                                          SAMPLE SOURCE
                                                                                                                                                                                                                             SPRING
                                                                                                                                            LAND SURFACE ALTITURE
SUSTAINED YIELD
YIELD MEAS METHOD
                                                                                                                                                                                                                                 3860.
                                                                                                                                                                                                                                                        1 7
                                                                                                                                                                                                                                                                             10
                                             E NUMBER BS-02
SAMELED 21-SEP-80
                                                                                                                                  TOTAL REPT WILL

SO WOLER TO COUNTRY

OF THE TOTAL SECTION

OF THE
                  DATE SAMPLED 21-SEP-80
TIME SAMPLED 13:00 HOURS
LAB + ANALYST MRMG*ENA
DATE ANALYZED 05-DEC-80
SAMPLE BANBLING 4120
METHOD SAMPLED GRAD
WATER USE UNUSED
                             DATE
                                                                                                                                                                   CASING TYPE
                                                                                                                                                PERFORATION INTERVAL
                  SAMPLING SITE SAND COULEE MINING DISTRICT \star NO. FIVE CK GEOLOGIC SOURCE HORRISON FORMATION
                                                                                                                                                                                                                                 HDZI.
                                                                                HG/L
                                                                                                                HERZI.
                                                                                                                                                                                                                                                            MEGZI.
                                                                                167.
                                                                                                                                                                                                                                 107.5
                                                                                                                      B.33 BICARBONATE
4.10 CARBONATE
0.73 CHLORIDE
                                                                                                                                                                                            (E03)
              CALCIUM
                                                  (CA)
                                                                                                                                                                                                                                                                  3.00
               MAGNESIUM (MG)
                                                                                                                                                                                                                                       С.
                                                                                    C1.3
               SODIUM
                                                   (NA)
                                                                                                                                                                                                  (CL)
                                                                                                                                                                                                                                        5.1
                                                                                                                                                                                                                                                                   0.17
                                                                                                                      0.15 SULFATE
1.87 NITRATE
               POTASSIUM
                                                     \langle K \rangle
                                                                                       5.60
                                                                                                                                                                                                                                 490.
                                                                                                                                                                                                                                                                 10.20
                                                                                                                                                                                                (504)
                                                                                                                                                                                                                                          .59
               IRON
                                                   (FE)
                                                                                   34.8
                                                                                                                                                                                             (AS N)
               MANGANESE (HN)
                                                                                      1.14
                                                                                                                       0.04 FLUORIDE
                                                                                                                                                                                                      (F)
                                                                                                                                                                                                                                           .87
                                                                                                                                                                                                                                                                    0.05
                                        ($102)
               SILICA
                                                                                                                                         PROSPRATE TOT (AS P)
                      TOTAL CATIONS
                                                                                                                    15.42
                                                                                                                                                                      TOTAL ANIONS
                                                                                                                                                                                                                                                                 13,54
                     STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                                                                                                         (SIGMA)
                                                                                                                                                                                                                                           5.94
       LABORATORY PH
FIELD WATER TEMPERATURE
CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
                                                                                                                   4.67 TOTAL HARDNESS AS CACOS
11.4 C TOTAL ALKALINITY AS CACOS
678.14 SODIUM ADSORPTION RATIO
973.40 RYZNAR STABILITY INDEX
1144. LANGLIER SATURATION INDEX
                                                                                                                                                                                                                                                      622.39
                                                                                                                                                                                                                                                     154.11
0.37
7.41
    LAR SPECICOND (HICROMNOS/CH)
                                                                                                               1144.
                                                                                                        VALUE
10.0 C
6.57
PARAMETER
TEMPERATURE, AIR (C)
                                                                                                                                           PARAMETER
CNDUCTVY, FIELD HICROMHOS
ALUMINUM, DISS (MG/L AS AG)
SILVER, DISS (MG/L AS AG)
RORON , DISS (MG/L AS B)
CADMIUM, DISS (MG/L AS CD)
                                                                                                                                                                      PARAMETER
                                                                                                                                                                                                                                                      VALUE
                                                                                                                                                                                                                                                   1124.
FIELD SH
FIELD PH
STRONTIUM, DISS (MG/L-SR)
TITANIUM DIS(MG/L AS TI)
ZINC, DISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR
SELENIUM, DISS (UG/L-SE)
                                                                                                                                                                                                                                                           <.002
                                                                                                           1.31
1.31
                                                                                                                                                                                                                                                          .05
                                                                                                                                            CHROMIUM, DISS (MG/L-CR)
COPPER,DISS (MG/L AS CU)
LITHIUM,DISS(MG/L AS LI)
                                                                                                            <.004
                                                                                                                                                                                                                                                            .002
                                                                                                            <.1
                                                                                                                                                                                                                                                             .014
ARSENIC, DISS(UG/L AS AS)
HERCURY, DISS(UG/L AS HG)
NICKEL, DISS (HG/L AS NI)
DISSLUD SOLIDS(CALC HG/L
                                                                                                                                                                                                                                                             .044
                                                                                                                                            MOLYBDENUM, DISS (MG/L-HG)
LEAD, DISS (MG/L AS PB)
                                                                                                                                                                                                                                                         <.02
                                                                                                            <.03
                                                                                                                . 34
REHARKS: WATER LOOKS PALE DRANGE * ORANGE AND WHITE PRECIPITATE IN FILTER *
R. SINGLES SPRING - GIFFEN MINE * SPRING CMITS OVER BROAD ARCA NEAR
WHERE MINE ADIT WAS PLUGGED TO SHUTOFF ACID MINE DISCHARGE *
LAB: FU FE OF .017 MG/L GIVES --.035 SIGMA *
                                                                  = HILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, HEG/L
ER LITER, FT = FEET, HT = HETERG, (H) = HEAGURED, (E) =
EPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL,
EXFLANATION: MG/L
MILLIEQUIVELENTS PER LITER.
ESTIMATED, (R) = REPORTED. T
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OTHER AVAILABLE DATA OTHER FILE NUMBERS:
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LAST EDIT DATE:
PROCESSING PROGRAM:
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27-MAY-83
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                                                                           F1730F V2 (11/3/81)
                                                                                                                                                           PRINTED:
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NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8082324

NG

CA

MG

30.4

PERCENT HEGAL (FOR PIPER PLUT)

K

0L S04 H003 1.3 75.8 22.7

0.03

0.0

#### WATER QUALITY ANALYSIS LAR NO. 8002325

STATE MONTANA

LATITUDE-LONGITURE 47D24'43'N 111D09'03'N SITE LOCATION 17N SE 7 CACE

UTM COORDINATES 712 N5250740 E488570 H8MG SITE CS-01

TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 STATION 1D 472443111070301

GEOLOGIC SOURCE 2C1MRSN\* \* SAMPLE SOURCE MINE DRAINAGE

DRAINAGE BASIN BB LAND SURFACE ALTITUDE 3490. FT < 10

AGENCY + SAMPLER MBMG\*JUD SUSTAINED YIELD

DOTTLE NUMBER CS-01 YIELD HEAS METHOD

DATE SAMPLED 21-SEP-80 TOTAL DEPTH OF NELL

TIME SAMPLED 08:00 HOURS SWL ABOVE(-) OR BELOW GS

LAB + ANALYST MBMG\*FNA CASING DIAMCTER

DATE ANALYST MBMG\*FNA CASING TYPE

SAMPLE HANDLING 4120 COMPLETION TYPE \*

MATER USE UNUSED

SAMPLING SITE SAND COULEE MINING DISTRICT\*SAND COULEE CK SCOLOGIC SOURCE MORRISON FORMATION

	HG/L	REGYL			MG/I,	HER/L
CALCIUM (CA)	93.5	4.67	BICARBONATE	(1003)		
HAGNESIUM (MG)	74.7	6.15	CARBONATE	(003)		
SODIUM (NA)	22.3	0.97	CHLORIDE	(CL)	٤.3	0.18
POTASSIUM (K)	2 . 4	0.06	SULFATE	(504)	780 <b>.</b>	20.40
IRON (FE)	12.4	0.67	NITRATE	(AS N)	.04	0,00
MANGANESE (MN)	. 8 5	0.03	FLUORIDE	(F)	3.4	0.18
SILICA (SIG2)	აც.5		PHOSPHATE TOT	(AS P)		
TOTAL CATIONS		12.54	TOTAL	CHOINA		20.76

STANBARD DEVIATION OF ANION-CATION BALANCE (SIGNA)

LARGRATORY PH	2.73	TOTAL HARDNESS AS	CACC3 540.9	23
FIELD WATER TERPERATURE	10.5 C	TOTAL ALKALINITY AS	CACG3	
CALCULATED DISSOLVED SOLIDS		SODIUM ADSORPTION	RATIO 0.4	42
SUM OF DISS. CONSTITUENT		RYZNAR STABILITY	INDEX	
LAR SPEC.COND.(MICROMHOS/CM)	1839.	LANGLIER SATURATION	INDEX	

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE+ AIR (D)	10.0 C	CNDUCTVY/FIELD MICROMHOS	1862.
FIELD PH	2.80	ALUMINUM, DISS (MG/L-AL)	47.5
NICKEL+DISS (MG/L AS NI)	+54	SILVER,DISS (MG/L AS AG)	<.002
LEAD+DISS (MG/L AS PB)	< . 0 4	BORON →DISS (MG/L AS B)	.12
STRONTIUM,DISS (MG/L~SR)	33.	CADHIUM,DISS(MG/L AS CD)	.018
TITANIUM DIS(MS/L AS TI)	.016	CHROMIUM, DISS (MG/L-CR)	.005
VANADIUM, DISS(MG/L AS V)	.006	COPPERIDISS (MOZE AS CU)	.030
ZINC:DISS (MG/L AS ZN)	1.55	LITHIUM, DISS(MG/L_AS_LI)	• 17
ZIRCONIUM DIS(MG/L AS ZR	<.004	MOLYXDENUM, DISS(MG/L-MO)	<.02
ARSENIC DISS(UG/L AS AS)		MERCURY DISS(UG/L AS UG)	
SELENIUM, DISS (UG/L-SE)	. 4	ACIDITY, TOT (MG/L-CACO3)	432.

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 04-MAY-81 BY: TP \*CLG
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEG/L (FOR PIPER PLOT)
CA MG NA K CL 504 HCC3 CO3
37.4 51.7 8.2 0.5 0.7 77.1 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: BOG2325

WATER QUALITY ANALYSIS LAB NO. 8002327

STATE MONTANA COUNTY CASCADE SITE LOCATION (8N SE LATITUDE -- LONGITUDE 2A00 6 MRMG SITE CS 02 DE STATION IN 477012111091101

\* SAMPLE SOURCE MINE DRAINAGE UTH COORDINATES TOPOGRAPHIC HAP HAP OFOLOGIC SOURCE ?? DRAINAGE BASIN DD LAND SURFACE ALTITUDE SUSTAINED YIELD 3850. FT = 10 AGENCY & SAMPLER BOTTLE NUMBER dr:/\*saugh YIELE MEAS METHOS TOTAL DEPTH OF WELL ABOVE() OR BELOW OS CASING DIAMETER 05-07 21-5EP-30 15:00 HOURS HRMG\*ENA DOTTLE NOMBER
DATE SAMPLED
TIME SAMPLED
LAB | ANALYST
DATE ANALYZED
SAMPLE HANDLING
METHOD SAMPLED CASING TYPE 18-558-81 4120 GRAS PERFORATION INTERVAL WATER USE UNUSED SAMPLING SITE SAME COULEE MINING DISTRICT\*COTTONWOOD CN GEOLOGIC SOURCE MORRISON FORMATION HG/I MEQ/L HS/1 MEG/S 17.22 BICARBONATE 12.24 CARBONATE 0.34 CHLORIRE 0.02 SULFATE 53.78 NITRATE 345. (CA) (HC03) CALCIUM MAGNESIUM (MG) 149. (003) 14.7 (NA) (CL) SODIUM 6400. .00 17.4 0.47 1057. 2.46 113.0 (K) (EE) POTASSIUM (SO4) 134.91 (AS N) 0.00 IRON MANGANESE (MN) 0.05 FLUORIDE 0.05 SILICA (SIGZ) PROSPHATE TOT (AS P) TOTAL CATIONS 87.00 TOTAL ANIONS 135.45 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 2.70 TOTAL HARDNESS AS CACO3 10.2 C TOTAL AUKALINITY AS CACO3 SODIUM ADSORPTION RATIO RYZNAR STADILITY INDEX LABORATORY PH 1474,75 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 0.17 LAB SPEC.COND. (MICROMHOS/CM) LANGLIER SATURATION INDEX 6287. VALUE PARAMETER VALUE PARAMETER CADUCTVY, FIELD HICROPHOS ALUMINUM, DISS (MG/L AL) SILVER, DISS (MG/L AS AG) BORON, DISS (MG/L AS CD) CADMIUM, DISS (MG/L AS CD) CHROMIUM, DISS (MG/L CR) COPPER, DISS (MG/L AS CU) LITHIUM, DISS (MG/L AS CU) ິຈີ 0 ດ 2 - 45 TEMPERATURE, AIR (C) 6747. 479. FIELD PH NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L AS NE) STRONTIUM, DISS (MG/L AS TI) TITANIUM DISS (MG/L AS TI) VANADIUM, DISS (MG/L AS V) 017 12.4 < . 04 1.06 .079 .21 ZINCEDISS (MG/L AS ZN) ZIRCONIUM DIS(MG/L AS ZR ARSENICEDISS(UG/L AS AS) SELFNIUM, DISS (UG/L-SE) LITHIUH, DISSCHOVE 170 52.9 AS LID . 05 2.03 2.650 2.8 1.0 MÔLYRBENÛM, BISS(HGZL-HG) HERCURY, BISS(UGZL-AS-HC) ACIDITY, TOT(MGZL-GACO3) REMARKS: WATER BUMPING ORANGE AND RED PRECIPITATE \* CLEAR AT SOURCE \*
1.5 HILES SOUTH STOCKETT \* SPRING EHITS FROM SPOIL PILE IN FRONT OF
CAVED ABIT \* FLOW MEASURED AT ROAD - GREATER AT SOURCE \*
LAR: H+=31 HG/L, --22 SIGMA, 135.9 TOTAL CATION MERVS/L \* EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEQUIVELENTS PER LITER. FT = FEET, MI = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL. MA 52 IJI 04FILE AT CTHER OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 04-MAY-81 BY: TF \*CLC
PROCESSING PROGRAM: F1730F V2 (11/3/01) PRINTED: 27-MAY 83

PERCENT MERZL (FOR PIPER PLOT)
CA MG NA K CL 904 HC03 C03
57.1 40.7 2.1 0.1 0.4 99.6 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8082327

## WATER QUALITY ANALYSIS

MONTANA COUNTY
47D20'12'N 111D09'10'W SITE LDCATION
712 N5242395 E488515 HRMG SITE
5TOCKETT 7 1/2' STATION ID
121MRSN\*111MTLG\* \* SAMPLE SOURCE
1 BE LAND SURFACE ALTITUDE
1 HBMG\*JJD SUSTAINED YIELD
2 CS-09 YIELD HEAS METHOD
3 TOTAL DEPTH OF WELL STATE CASCADE 18N 5E 6\*CCAC CS-09 472012111091001 MINE DRAINAGE 3855: FT < 10 LATITUDE-LONGITUDE UTH COORDINATES Z13
TOPOGRAPHIC HAP STO
GEOLOGIC SOURCE 22
DRAINAGE BASIN RE
AGENCY + SAMPLER HRO
ROTILE NUMBER CS DATE SAMPLED 03-MAR-81 TIME SAMPLED 14:00 HOURS TOTAL DEPTH OF WELL SWL ABOVE(-) OR RELOW OS CASING DIAMETER 03-MAR-81 14:00 HOURS HRMG\*FNA 22-AFR-81 4120 GRAE LAR F ANALYST DATE ANALYZED SAMPLE HANDLING METHOR SAMPLED CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL WATER USE UNUSER CAMPLING SITE STOCKETT - SAND COULEE MINING DISTRICT SECURGE SOURCE MORRISON FORMATION MG/I. HEGZL HGZI. HEQ/L 17.76 BICARBONATE CALCIUM (CA)
MAGNESIUM (MG) 330. 155. (RC03) (003) 135. 14.1 1035. 1035. 103.0 (NA) 0.31 CHLORIDE 0.05 SODIUM 1.7 6908. 18 7.46 0.07 57.01 0.09 POTASSIUM (K) IRON (FE) MANGANESE (MN) SULFATE NITRATE (504) 0.01 (ÀŠŰŃ) (F) FLÜÖRIDE SILICA (SIG2) PHOSPHATE TOT (AS P) TOTAL CATIONS 88.70 TOTAL ANIONS 144.24 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 2.82 TOTAL HARDNESS AS CACO3 8.6 C TOTAL ALKALINITY AS CACO3 SOBJUM ADSORPTION RATIO RYZNAR STABILITY INDEX 51. LANGLIER SATURATION INDEX LARGRATORY PH 1536.50 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 0.16 LAB SPEC.COND. (HICROMHOS/CH) 6251. PARAMETER PARAMETER VALUE VALUE 6826. 1270. 5431. TEMPERATURE, AIR (C) ្រ TEMPERATURE, AIR (C)
FIELD PH
IRON, TR (HG/L AS FE)
ARSENIC, TR (UG/L AS AS)
ALUMINUM, DISS (HG/L AS AG)
SILVER, DISS (HG/L AS AG)
DORON, DISS (HG/L AS B)
CADMIUM, DISS (HG/L AS CD)
CHROMIUM, DISS (HG/L AS CU)
COPPER, DISS (HG/L AS CU)
LITHIUM, DISS (HG/L AS LI)
HOLYBDENUM, DISS (HG/L-HO)
GELFNIUM, DISS (UG/L-SE) CNDUCTVY, FIELD HICROMHOS 10. CNBUCTVY; FIELD HICROMHOS ALUHINUM; TR (MG/L AS AL) ACIDITY; TOT (MG/L AS AL) SELENIUM; TR (UG/L AS SE) NICKEL; DISS (MG/L AS NI) LEAD; DISS (MG/L AS PB) STRONTIUM; DISS (MG/L AS TI) VANADIUM; DISS (MG/L AS ZN) ZINC; DUSH DISCHS/L AS ZN) 2.53 1290. 12.8 6.0 500. ୍ଦି ଦେଉ .33 .112 .144 .103 .014 .154 .728 1.42 4.35 ZÍRCÓNÍÚM DIS(MÖZL AS ŹR ARSENIC, DISS(UGZL AS AS) .025 SELFNIUM, DISS (US/L-SE) .6

REMARKS: SAMPLE CLEAR -- NO PRECIPITATE \* DOWNSTREAM THERE IS GRANGE AND WHITE PRECIPITATE AND GREEN GLIME \* SAMPLE FROM SPRING AT SPOIL PILE BY THE BINE \* AT ROAD, PH=2.72, S.C.=6725 \*

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MSG/L = MILLIERUIVELENTS PER LITER. FT = FEET, MT = METERS. MSG/L = MSGSURED, MSG/L = MSGSURED, MSGSU

OTHER AVAILABLE DATA Y
OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 19-FEB-82 BY: TP \*JKS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT HER/L (FOR PIPER PLOT)
CA HG NA K CL 904 HC03 C03
57.2 40.3 2.0 0.2 0.0100.0 0.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 8100061 ANALYSIS NOT IN FILE: 8101008

```
COUNTY CASCADE

(59*W STTE LOCATION 19N SE 20 RBDC

750 MRMG SITE DG-01

ALLS 7 1 STATION ID 472321111075901

* SAMPLE SOURCE MINE DRAINAGE
LAND SURFACE ALTITUME 3590. FT 50

YIELD MEAC METHOD
STATE NUNTANA
LATITUDE-LONGITUDE 47D23/21*N 111D07/57*W
UTM COORDINATES 712 N5248170 F487750
TOPOGRAPHIC MAP SOUTHFAST GREAT FALLS 7 1
GEOLOGIC_SOURCE 221MRSN*111SP8N* *
     UTH COORDINATES
TOPOGRAPHIC MAP
GEOLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAMPLER
DOTTLE NUMBER
                                                   E: E:
                                                    MRMG#JJD
                                                                                            YTELD MEAS METHOR
TOTAL REPTH OF WELL
SWL ABOVE(-) OR RELOW OS
CASING DIAMETER
                                                    05-05
        DATE SAMPLED 21-SEP-30
TIME SAMPLED 10:00 HOURS
LAR + ANALYST MRHG*FNA
DATE ANALYZED 18-FEB-81
SAMPLE HANDLING 4120
METHOD SAMPLED GRAB
                                                                                                                     CASING TYPE
COMPLETION TYPE
                                                                                                       PERFORATION INTERVAL
                        WATER USE UNUSED
             SAMPLING SITE SAND COULEE MINING DISTRICT*SAND COULEF CK
        GEOLOGIC SOURCE MORRISON FORMATION
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CALCIUM (CA)	MG/L 131.		BICARBONATE	(R003)	HG/L	MERZI
HAGNESTUM (MG) SODIUM (NA) POTASSIUM (K)	62.6 13.6 2.4	0.59	CARBONATE CHLORIDE SULFATE	(CO3) (CL) (SO4)	5.2 1437.	0.15 29.92
IRON (FE) MANGANESE (MN) SILICA (SIO2)	31.3 .70 99.2		NITRATE FLUORIDE PHOSPHATE TOT	(AS N) (F) (AS P)	.04 3.54	0.00
TOTAL CATIONS		16.54	TOTAL			30.25

#### STANDARD BEVIATION OF ANION-CATION RALANCE (SIGMA)

LABORATORY PH	2.31	TOTAL HARDNESS AS	CACO3	709.62
FIELD NATER TEMPERATURE	11.00	TOTAL ALKALINITY AS	CACG3	
CALCULATED DISSOLVED SOLIDS		SODIUM ADSCRPTION	RATIO	0.22
SUM OF DISS, CONSTITUENT		RYZNAR STABILITY	INDEX	
LAR SPEC.COND.(HICROHHOS/CH)	2522 *	LANGLIER SATURATION	INDEX	

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	6. C	CNDUCTVY, FIELD MICROMHOS	3027.
FIELD PH	2.50	ALUMINUM, DISS (MG/L-AL)	33.6
NICKEL/DISS (MS/L AS NI)	.36	SILVER,DISS (HG/L AS AG)	.006
LEAD, DISS (MG/L AS PB)	< . 0 4	BORON →DISS (MG/L AS B)	.10
STRONTIUM,DISS (MG/L~SR)	.73	CADMIUM, DISS(MS/L AS DD)	.016
TITANIUM DIS(MG/L AS TI)	.033	CHROHIUM, DISS (HG/L-CR)	.013
VANADIUM, DISS(MG/L AS V)	.016	COPPER,DISS (HS/L AS CU)	.035
ZINC/DISS (MG/L AS ZN)	1.04	LITHIUM, DISS(MG/L AS LI)	.17
ZIRCONIUM DIS(MGZL AS ZR	.005	MOLYBDENUM,DISS(MG/L-MO)	<.02
ARSENIC:DISS(UG/L AS AS)	< . 1	MERCURY,DISS(UG/L AS HG)	03
SELENIUM, DISS (UG/L~SE)	. 4	ACIDITY, TOT (MG/L-CACO3)	722.

REMARKS: WATER IS MURKY - FILTERS POORLY DUE TO SEDIMENT \* WATER SEEPS OVER BROAD AREA OF MINE SPOIL \* SOME MIXING WITH HIGHER PH \* NATURAL SPRING DISCHARGE (PH FROM 3-5) \* OUTFLOW AT ROAD AT 1GPM, PH=2.78 \* WATER LAB: SEEPS RAPIDLY BACK INTO GROUND ALORG DRAINAGE CHANNEL \* LAB: H+=11.3 MG/L, -.01 SIGMA, 30.3 TOTAL CATION MEGVS/L \*

EXPLANATION: MG/L = MILLIGRAMS PER LUTER, UG/L = MICROGRAMS PER LITER, MEG/L = MILLIEQUIVELENTS PER LITER. FT = FECT, MT + MCTERS. (M) = MEASURED, (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

52 P.W aw WA WI CIL AI BIRER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: COST: TP #CLC BY: 04-MAY-81 F1730P V2 (11/3/81) 27 HAY 83 PRINTED:

> PERCENT MER/L (FOR PIPER PLOT) CA MG NA K CL 504 HC03 CA MG 003 0.5 22.5 60.7 34.7 0.4 4.0 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8002326

#### APPENDIX B

#### GEOLOGY

A comprehensive description of the Mesozoic stratigraphy of the area is presented in Silverman and Harris (1967), and comments regarding the geology of the area are largely derived from their report and from field inspection.

#### B.l Madison Group (Mississippian)

The Madison Group is the oldest geologic unit exposed in the area. Its top is exposed in several localities along the bottoms of Cottonwood, Number Five and Sand Coulees. Outcrops are not extensive; the largest observed exposure is about thirty feet thick. Feltis (1980, 3) shows the top of the Madison in this area to dip to the north-northwest at a relatively uniform dip of 50-70 feet/mile (about one degree). However, exposures in this area suggest that the top of the formation may be irregular, projecting local domes or knobs. It is probably located at shallow (<300 feet) depth in the subsurface throughout the study.

The Madison is overlain unconformably by Jurassic sediments of the Ellis Group. This unconformity is angular, as exposed 0.5 km north of Stockett, where folded Madison strata dip 25 degrees north-northeast beneath flay-lying sandstone of the Ellis. The Madison may exhibit more complex structure in the subsurface than the gently-dipping Cretaceous and Jurassic sediments which overlie it.

The lithology of the Madison is grey, coarsely-crystalline limestone and dolomitic limestone, with chert grains and a diverse

biohermal fossil assemblage. It occurs both in thin, flaggy beds and in massive biohermal strata. Some fossil casts have been refilled with either calcite or gypsum. Local residents report that the limestone is locally cavernous along Sand Coulee Creek farther south towards the mountains. Water well drillers have reported encountering cavernous zones in the upper Madison in the Stockett and Sand Coulee area.

#### B.2 Swift Formation and Ellis Group (Jurassic)

Sandstone of the Swift Formation, the upper member of the Ellis Group, is distinctive in outcrop as a cemented, cross-bedded, grey, massive— to flaggy-bedded sandstone. Outcrops are found along coulee bottoms in the upper reaches of the Sand Coulee Creek drainage, particularly south of Stockett. In some localities, it unconformably overlies the Madison, but it usually overlies yellow and grey shales and mudstones of the lower Ellis Group. The fine-grained sediments of the Ellis are poorly resistant to erosion and are not well exposed in the area.

#### B.3 Morrison Formation (Jurassic)

The Morrison Formation consists of 50-250 feet of grey mudstone, with interbedded lenses of limestone, sandstone, coal and shale. Coal mined in the Sand Coulee area is from bed(s) at or near the top of the Morrison. The uppermost coal bed is directly overlain by a cemented conglomeratic channel sandstone at the base of the Kootenai Formation (Cretaceous).

Although the upper coal seam was the primary target of mining in this area, at least one other minable seam may occur in the subsurface

of the area. In the Giffin mine workings, local residents report that mining took place at two separate levels separated by approximately 30 feet of interburden material.

Morrison outcrops are found in this area along the mid-slopes of the coulees. The upper part of the Morrison consists of coal, carbon-aceous shale and fine-grained sandstone lenses, up to a total thickness of sixty feet. The coal bed ranges from 1-12 feet thick, with varying proportions of interbedded carbonaceous shale. The thickness of these shale strata was one of the controls on the profitability of mining.

Sandstone lenses in the Morrison are up to 35 feet thick. They are clean fluvial deposits and weather orange, making them difficult to distinguish from some of the sandstones in the overlying Kootenai. Perhaps the most diagnostic characteristic of the Morrison is its varied assemblage of interbedded lithologies, including shale, mudstone, coal, sandstone and fresh water limestone.

#### B.4 Kootenai Formation (Lower Cretaceous)

The Kootenai Formation is a sequence of numerous lensaic, discontinuous sandstone beds from one to 50 feet thick, interbedded with green and grey mudstone. It forms the coulee walls and underlies the upland benches between coulees throughout the study area. The basal sandstone unit of the Kootenai, the Third Cat Creek equivalent in this area, overlies the coal in the Upper Morrison with an erosional unconformity. This unit represents the first coarse channel deposits of the major river system which established itself across the Upper Jurassic land surface.

Except for the basal sandstone, the numerous sandstone beds in the

upper Kootenai are relatively discontinuous. Most individual beds cannot be traced over long distances.

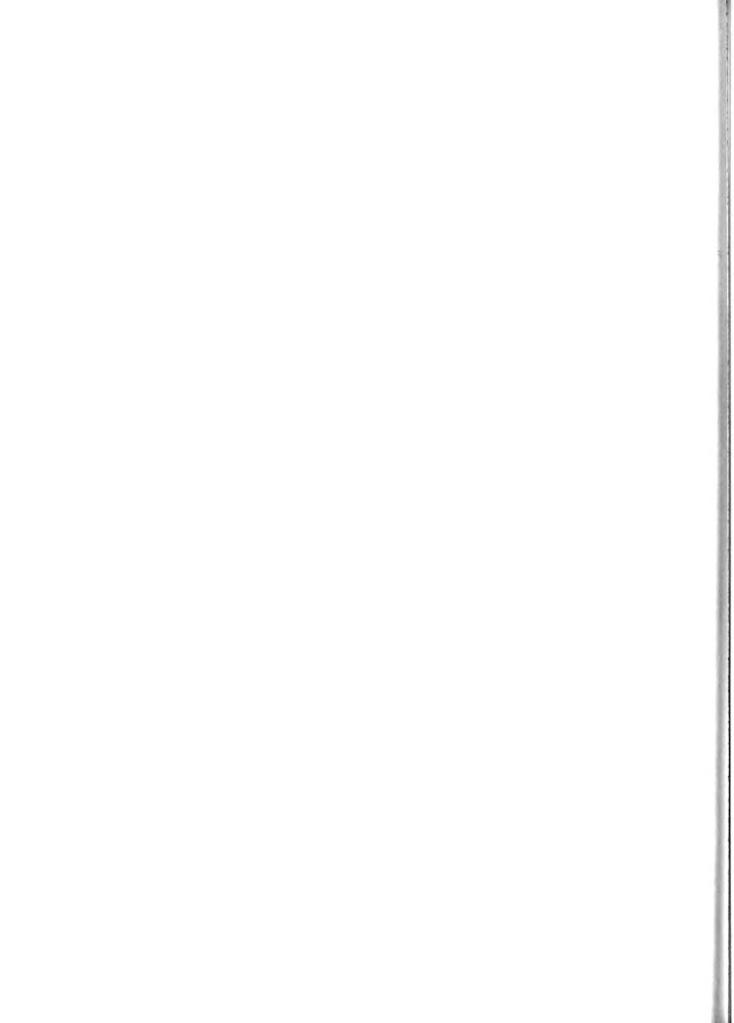
#### B.5 Glacial Deposits

According to Coulton et al. (1961), the limit of Wisconsinan continental glaciation lies just to the north of the Sand Coulee area. No known till or drift deposits occur within the valley. There is a large pre-glacial channel of the Missouri River which runs east-west from the modern Missouri River south of Great Falls, at the Sand Coulee Creek delta, directly west to the town of Fife. The flow of Sand Coulee Creek turns abruptly to the west as it encounters this channel. The channel is filled with sand, gravel, silt and clay deposited by glaciers and glacial lakes over which the lower reach of Sand Coulee Creek flows at a gentle gradient of 9-10 feet/mile (about 2%).

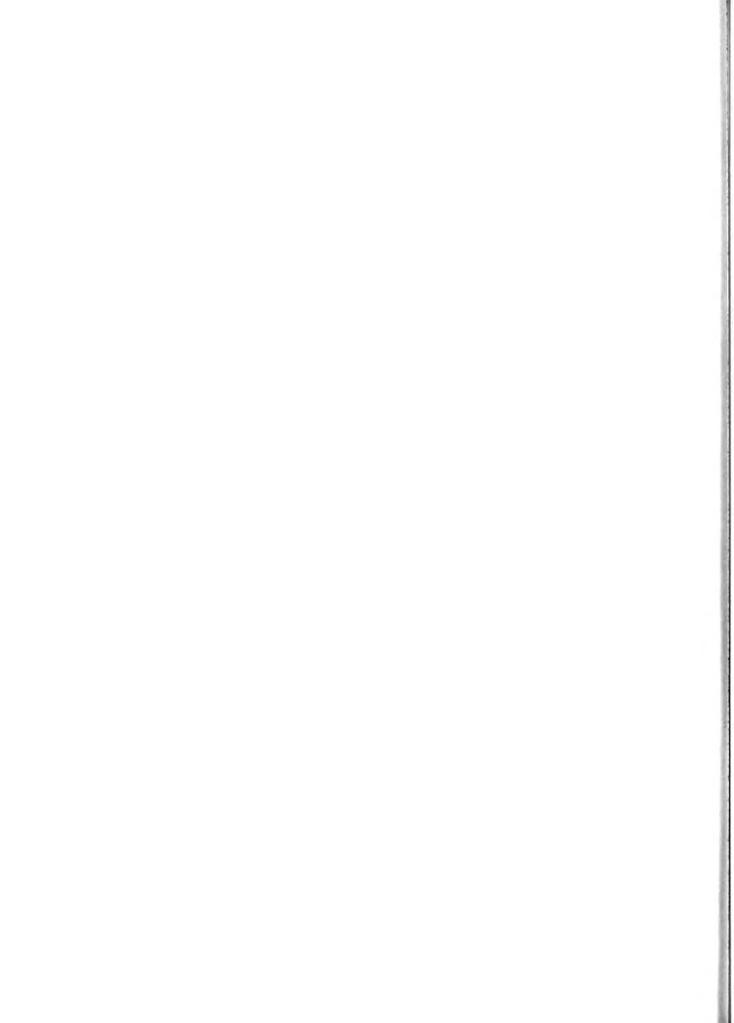
#### B.6 Alluvial Deposits

Thin alluvial deposits of Quaternary and possibly Tertiary age lie along the coulee bottoms of Straight, Cottonwood, Number Five and Sand Coulee Creeks. North of Tracy, these alluvial deposits inter-finger with the outwash and lacusterine deposits of the ancient Missouri channel. Thickness of the alluvial cover is variable. Although little data on its thickness distribution are available, it is probable that nowhere south of Tracy is it greater than 100 feet.

# APPENDIX C HYDROGEOLOGICAL DATA



DOMESTIC WELL INVENTORY FIELD SHEETS



COUNTY ASCADE			R. 4 O W	sec2_	TRACT_BODA
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TOWN	SUBDIVISION			BLOCK	LOT
OWNER'S NAME DOIVALD	JACOBS		_ ADDRESS .		
		PHONE NUMBE	ER	YEAR	
ALT. LAND SURF. AT WELL MSL	4303 n.		LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD	<i>90</i> n.	INTERVAL (F	T.)		
PUMPING LEVEL BELOW LSO	n.	FROM TO		DESCRIPTION	
STATIC WATER LEVEL* BELOW LSO _	n.				
YIELD IN GALLONS PER MIN.			NO	L06	
OW TESTED TIA	AE (HR.)				
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in. FROM ft.	. TO ft.				
CASING TYPE	<del></del>				
ERFORATED INTERVAL ft.	то п.				
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n.	. TO ft.				
ERFORATION DESC.					
UMP SIZE (HP.) TYPE					
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HOW DRILLED					
BY WHOM	_ LIC				
WELL USE					
SOURCE OF INFO: WELL APPROP.	_				
DRILLER OWNER USQS_	scs				
OTHER:					
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HAS WELL LOCATION BEEN VERIFIED					
BY WHOM TOS BATHE AGE	NCY MBM6		-	<del></del>	
DATE VERIFIED					
MEAS. POINT ABOVE LSD	n. DATE				
TOTAL DEPTH BELOW LSD					
UMPING LEVEL BELOW LSO 74.88	n	-			
WL BELOW LSD 74.88	n. 1-19-32	-		<del></del>	
TIELD IN GPM					
NATER TEMP. C					
PECIFIC COND. et 25°C					
ABMG FILE NUMBER		<b>———</b>			
ONR FILE NUMBER					
VELL FORM NUMBER					
IBMG WQ LAB. NUMBER				SKETCH MAP	1 225
YS 2000 NUMBER				white she	
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DWNER'S NAME  SUBDIVISION  BLOCK  LOT  ACCRETE NAME  SUBDIVISION  ACCRETE NAME  ACCRET	O I H ONG	" " W.	U	лтм	_ N	E
MONE NUMBER YEAR  NOTAL DEPTH BELOW LSO	TOWN SUBDIVISION	·				
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HAS WELL LOCATION BEEN VERIFIED YES  BY WHOM TOS BOTAL AGENCY MBMG  DATE VERIFIED 2-19-82  MEAS. POINT ABOVE LSD 3.19 ft. DATE  TOTAL DEPTH BELOW LSD 405 ft.  NUMPING LEVEL BELOW LSD 6.10.10.10 ft.  WILL BELOW LSD 108.10 ft.  WHICH BELOW LSD 108.10 ft.  WEST SINGLE OF TOO DESTRUCTION OF THE PROPERTY OF TOO DESTRUCTION OF THE PROPERTY OF TOO DESTRUCTION OF THE PROPERTY OF THE PROPERTY OF TOO DESTRUCTION OF THE PROPERTY		+				
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MEMARKS:  MEMARKS:  MEMARKS:  MEMARKS:  MEMARKS:  METCH MAP  MEMARKS:  MEMAR	OMPING LEVEL BELOW LSO					
WATER TEMP. C  PECIFIC COND. at 25°C  355  8-19-82  MBMG FILE NUMBER  DINR FILE NUMBER  WELL FORM NUMBER  MS 2000 NUMBER  DITHER:  Sond Coulee Crk, Bridge at Creamery bldg.  397 @ 30.6°C	SWL BELOW LSO 106.06 M. 4-19-82					-
PECIFIC COND. at 29°C  355  8-19-82  ABMG FILE NUMBER  ONR FILE NUMBER  WELL FORM NUMBER  ABMG WG LAB. NUMBER  WYS 2000 NUMBER  OTHER:  397  30.6°C  355  8-19-82  West side of road just off of the control of the cont	/IELD IN GPM					
ABMG FILE NUMBER  ONR FILE NUMBER  VELL FORM NUMBER  ABMG WG LAB. NUMBER  OTHER:  Sond Coulee Crk. Bridge at  Creamery bldg.  397 @ 30.1°C						
SOUR FILE NUMBER  VELL FORM NUMBER  ABMG WG LAB. NUMBER  VYS 2000 NUMBER  STHERI  SOURCE Crk, Bridge at  Creamery bldg.	PECIFIC COND. at 25°C 355 8-19-82	2				
SELL FORM NUMBER  SIBMO WO LAB. NUMBER  VS 2000 NUMBER  STHER:  Sond Coulee Crk. Bridge at  Creamery bldg.  397 @ 30.6°C	IBMG FILE NUMBER					
SEMARKS:  397 @ 30.6°C   SKETCH MAP  West side of road just off of the content of	NR FILE NUMBER					
VS 2000 NUMBER  DITHER:  Sond Coulee Crk. Bridge at  Creamery bldg.  397 @ 30.6°C	VELL FORM NUMBER				·	
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COUNTY CASCADE T. LE	-	R	4 BOYN SEC. // TRACT AAAS
AT N. LONG	w.		UTM NE
			BLOCK LOT
WHER'S NAME DONALD A. YURC	K		ADDRESS STOCKETT MT. 59480
	PHONE N	HUMBER,	YEAR
LT. LAND SURF. AT WELL MSL 4075 N.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 131 n.	INTERV	AL (FT.)	
UMPING LEVEL BELOW LSD 125 H.	FROM	то	DESCRIPTION
STATIC WATER LEVEL® BELOW LSD	0	4	TOP Soil
VIELD IN GALLONS PER MIN.	4	30	Broken Sandstone cons
OW TESTED BALLER TIME (HR.) 1	1	100	AND SANDSTONE BENLLERS
F F, SHUT-IN PRESS. IN PSI	30	38	DARK BROWN-GREY SHALE
DEOLOGICAL SOURCE OF HO SANDY SHALE	3.8	71	HARA-GRAY LIMY SHALE
LOOTENA & MODELON	41	43	LIGHT GRAS SHATE
18 0 18		48	MARGON SHAIC
CASING DIA & BIN. FROMO n. TO65_ n.	48	49	Red Rock
in. FROM ft. TO ft.	49	58	Red ROCK AND SHALE
CASING TYPE STEEL		76	VERIGATED LIMEY SANDROCK
PERFORATED INTERVAL 3/ n. TO n.	عما	1/6	2 GPM 65-70
<u>_6/</u>		81	MAROON SHALEROCK
n. TO n.	81	84	HARD RED LIMEY SANDROCK
PERFORATION DESC. 15" 115			VERIGATED SHALE ROCK
PUMP SIZE (HP.) TYPE	84	90	
PUMP SIZE (HP.) TYPE	90	96	VERIGATED SHALE
HOW OBLILED (ABIL)	96	1/02	VERIGATED SAND ROCK
BY WHOM PAT BYRNE LIC. 3/B	103	10.5	Red Rock
WELL USE STOCK & DOMESTIC	105	120	
SOURCE OF INFO: WELL APPROP.	120	124	
DRILLER OWNER USQS SCS	136	124	COAL
OTHER	129	131	DARK GRAY SANDY SHALE
<b>V</b>			
HAS WELL LOCATION BEEN VERIFIED Yes		-	
BY WHOM HERMAN MOOREAGENCY MBMG		<del>-</del>	
DATE VERIFIED		-	
MEAS. POINT ABOVE LSD ft. DATE		+	
TOTAL DEPTH BELOW LSO ft		+	1.27
PUMPING LEVEL BELOW LSD ft.	6,0	1K	137.19
SWL - BELOW LSO 7.70 m. 2/2/82			
VIELD IN GPM 7.2 421/82		-	
WATER TEMP. C /2./ (/21/82	-	+	
SPECIFIC COND. at 25°C 677 421/82		<b></b>	
MBMO FILE NUMBER		+	
DNR FILE NUMBER		-	
WELL FORM NUMBER			
MBMQ WQ LAB. NUMBER	<del></del>	لثث	BRETCH MAD
SYS 2000 NUMBER	1:1:-1:		Trelett
OTHER:	1-1-11		[ ]
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REMARKS:		۸ لتلت	j / <u>/</u> (227)
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## SPRING

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LAT N. LONG	" w.		UTM	_ N	_ ε	
TOWN SUBDIVISION _				BLOCK	LOT	
OWNER'S NAME RICK YUREK	<del></del>		ADDRESS _	TUANS RT.	STOCKETT	
	PHONE N	IUMBER_		YEAR _		
ALT. LAND SURF. AT WELL MSL 3880 H.	LITHOLOGIC LOG					
TOTAL DEPTH BELOW LSD ft.	INTERV	AL (FT.)				
PUMPING LEVEL BELOW LSD ft.	FROM	то		DESCRIPTION		
STATIC WATER LEVEL* BELOW LSOft.						
YIELD IN GALLONS PER MIN.		<del>  </del>				
HOW TESTED TIME (HR.)		<del>                                     </del>		<del></del>		
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GEOLOGICAL SOURCE OF H20 KOOTE NAI						
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In. FROM ft. TO ft.		<u> </u>		. <u>.</u>		
CASING TYPE						
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ft. TO ft.						
ft. TO ft.						
PERFORATION DESC.				<u>.</u>		
PUMP SIZE (HP.) TYPE						
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HOW DRILLED						
BY WHOM LIC				<del></del>		
WELL USE						
SOURCE OF INFO: WELL APPROP.	<b></b>					
DRILLER OWNER USGS SCS						
OTHER:						
11.146 Yas						
HAS WELL LOCATION BEEN VERIFIED YES				····		
BY WHOM HENDING MORE AGENCY MBMG						
DATE VERIFIED 6/0//82						
MEAS. POINT ABOVE LSD ft. DATE	-					
TOTAL DEPTH BELOW LSO ft	-					
PUMPING LEVEL BELOW LSD ft.		-				
SWL+ BELOW LSD					· ·	
YIELD IN GPM	-	-	-			
WATER TEMP. C	-	-				
SPECIFIC COND. at 25°C 372 (42//82	-					
MBMG FILE NUMBER						
DNR FILE NUMBER						
WELL FORM NUMBER	-		Yure, to	KETCH MAP		
MBMG WQ LAB. NUMBER		4	Yure to pr	NO ALPE!		
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COUNTY CASCADE T. 1	& North	R	4 Emm sec.	23	TRACT ABBE
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TOWN SUBOIVISION				LOCK	LOT
OWNER'S NAME RAIPH SINGLE					
	PHONE NU	MBER_		YEAR	
ALT. LAND SURF. AT WELL MSL 3910 ft. TOTAL DEPTH BELOW LSD 55 ft.					
	INTERVA	L (FT.)			
PUMPING LEVEL BELOW LSO R. STATIC WATER LEVEL® BELOW LSO	FROM	то	DES	CRIPTION	
YIELD IN GALLONS PER MIN.  HOW TESTED TIME (HR.)					
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GEOLOGICAL SOURCE OF H20 CON TOWE					
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PERFORATION DESC.	<del></del>	-			<del></del>
PUMP SIZE (HP.) TYPE	<del></del>				
DATE WELL COMPLETED	<del></del>				
HOW ORILLED	<del>                                     </del>				
WELL USE DOMESTIC + STOCK	<del></del>				
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SOURCE OF INFO! WELL APPROP.		-			
ORILLER OWNER X USQS SCS	<del> </del>	+			
OTHER:	-	$\rightarrow$			<del></del>
HAS WELL LOCATION BEEN VERIFIED YEL	-	<del></del>			
BY WHOM HERMAN & STORE CAGENCY MO. MG	-				
DATE VERIFIED 6/04/22			<del></del>		
	<del></del>				
MEAS. POINT ABOVE LSO ft. DATE	<del> +</del>				
TOTAL DEPTH BELOW LSD ft	-				
PUMPING LEVEL BELOW LISO ft.					
SWL* BELOW LSD			<del></del>		
VIELD IN GPM  9 20 6/4/21					
WATER TEMP. C 7.d (109/01)					
SPECIFIC COND. at 25 C SAS 621182	<b></b>	+			
MBMG FILE NUMBER					
ONR FILE NUMBER WELL FORM NUMBER					<del></del>
	<del></del>		SKETCH	100	
MBMG WQ LAB. NUMBER	[ ] P	7 .			-
SYS 2000 NUMBER		1 7	7 10	570427	l
OTHER:		7 /	1 _	_	
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			11/	4069	
F - FLOWING		3 D.	4		C - 5
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TOWN SUBDIVISION				BLOCK _	LOT		
OWNER'S NAME <u>FUGENE</u> Vice		^	ADDRESS _	EDEN !	RT. STOCKETI		
	PHONE N	JMBER_		YEA	AR		
ALT. LAND SURF. AT WELL MSL 4340 M.							
TOTAL DEPTH BELOW LSD 4340 m.	INTERV	AL (FT.)					
PUMPING LEVEL BELOW LSD	FROM	то		DESCRIPTIO	N		
STATIC WATER LEVEL® BELOW LSO 39' ft.							
YIELD IN GALLONS PER MIN.			<del></del> -				
HOW TESTED TIME (HR.)	-						
GEOLOGICAL SOURCE OF H20 SEND STONE	-				<del></del>		
GEOLOGICAL SOURCE OF H20 DENOSTONE							
KOUTENAI				<del></del>			
			<del></del>				
CASING DIA. Le In. FROM ft. TO ft.	-						
In. FROM ft. TO ft.							
CASING TYPE STEEL	-						
PERFORATED INTERVAL ft. TO ft.	-			<del> </del>			
tt. TO tt.	<del></del>			<del></del>			
ft. TO ft.					·····		
PERFORATION DESC.							
PUMP SIZE (HP.) TYPE							
DATE WELL COMPLETED							
BY WHOM FRANKLIN LIC.							
WELL USE Demested & STOCK			<del></del>				
SOURCE OF INFO: WELL APPROP.							
DRILLER OWNER USGS SCS			<del></del>				
OTHER:							
HAS WELL LOCATION BEEN VERIFIED Yes							
BY WHOM HERMAN MOORE AGENCY M.B.MG.							
DATE VERIFIED 6/07/82							
MEAS, POINT ABOVE LSD ft. DATE							
TOTAL DEPTH BELOW LSD ft.			-				
PUMPING LEVEL BELOW LSD ft.							
SWL* BELOW LSD		I					
YIELD IN GPM							
WATER TEMP. C 13.83 6/07/22	I						
SPECIFIC COND. at 25°C /04/ 4/07/82							
MBMG FILE NUMBER							
DNR FILE NUMBER							
WELL FORM NUMBER							
MBMG WQ LAB. NUMBER		-	(0145	SKETCH MAP			
SYS 2000 NUMBER		<u> </u>	GREATAILS	$\overline{}$			
OTHER:	28-	<u>"</u> " ↑	62	( <b>b</b> )	/		
	11111	41	Y				
REMARKSI		$\square$ $N$					
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COUNTY CASCADE T. L	S (A)	R	5 Earw	sec. 6	TRACT BBD
4 1 H					
OWN SUBDIVISION					
WHER'S NAME MATT FRISNEGGO	er		ADDRESS _	STUCKE	Π
		UMBER_		YEA	A
NLT. LAND SURF. AT WELL MSL 3695 N. OTAL DEPTH BELOW LSD			LITHO	roaic roa	
TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)			
THE THE SELOW LSD UNDER THE TENER OF THE TEN		то		DESCRIPTIO	•
VIELD IN GALLONS PER MIN.					
OW TESTED TIME (HR.)		-			
F F, SHUT-IN PRESS. IN PSI					
MORP JAN					
ASING DIA					
ASING DIA.	1 1				
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ERFORATED INTERVAL n. TO n.					
n. TO n.	1				
n. TO 1L					
ERFORATION DESC.					
UMP SIZE (HP.) TYPE	<del> </del>		<del></del>		
DATE WELL COMPLETED					<del></del>
HOW DRILLED					
WHOM LIC					
WELL USE (INUSE)	-				
OURCE OF INFO: WELL APPROP.		-			
DRILLER OWNER X USGS SCS					
OTHER:					
Y	-				
HAS WELL LOCATION BEEN VERIFIED Ses	-				· -
BY WHOM HERMAN MOORE AGENCY MBMG					
DATE VERIFIED 6/02/82	-				
MEAS. POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD R R R.	-				
SWL BELOW LSO 24.48 m. (e/02/82					
VIELD IN GPM					<del> </del>
NATER TEMP. C				<del></del>	<del></del>
PECIFIC COND. at 25°C	-				
ABMG FILE NUMBER					
ONR FILE NUMBER					
VELL FORM NUMBER					
MBMG WQ LAB. NUMBER	بعدنيا	~		SKETCH MAP	
SYS 2000 NUMBER		₩ +-	1 pugo		
OTHER:	6		-	1250 /	O-en Linchett
REMARKS, DOULED TO CO 1500 07 140		N	١ ل		
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WATER NEVER USED Hunkel ONIO		. •	•	Day well	
Yestell water				1	
F . FLOWING				1 5	C-7
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COUNTY CASCADE T. L	E_(Nors	R	5 @ww	sec	TRACT BBD
0 1 H 0 1	н <b></b> w.		JTM	_ N	e
TOWN SUBDIVISION				BLOCK _	LOT
OWNER'S NAME ANNA DOLENA			DORESS _	lox 6/ S	Tockett
	PHONE N	UMBER_		YEA	R
ALT. LAND SURF. AT WELL MSL 3800 M.			LITHOLO	GIC LOG	
TOTAL DEPTH BELOW LSO 3.5 M.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	FROM	то		DESCRIPTIO	N
STATIC WATER LEVEL BELOW LSO THE					
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H20					
Allowing	_				
	-		<u> </u>		
CASING DIA. 2 In. FROM ft. TO ft.				<del></del>	<del></del>
in. FROM ft. TO ft.					<del></del>
CASING TYPE			· · · · · · · · · · · · · · · · · · ·		
PERFORATED INTERVAL ft. TO ft.	-	-			
ft. TO ft.		-			
ft. TO ft.		-			
PERFORATION DESC.		-			
PUMP SIZE (HP.) TYPE	-	-			
DATE WELL COMPLETED	-	-			
HOW DRILLED		-			
BY WHOM LIC		-			<del></del>
WELL USE DeMETTE + STOCK	-	-			
SOURCE OF INFO: WELL APPROP.		-			
DRILLER OWNER X USGS SCS	-	-			
OTHER:		-			
<b>k</b> .		-			
HAS WELL LOCATION BEEN VERIFIED S	-	-			
BY WHOM HERMAN MOORE AGENCY MRMG	-	-			
DATE VERIFIED 6/04/82	-				
MEAS. POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSO ft					
PUMPING LEVEL BELOW LSO ft.		-			
SWL BELOW LSO /5.98 M. /4/82					
YIELD IN GPM	-			<del></del>	
WATER TEMP. C				<del></del>	
SPECIFIC COND. at 25 C 483 404/32	-		<del></del>		
M8MG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER			- OUMO	KETCH MAP	
MBMG WQ LAB. NUMBER				ELLO TAP	
SYS 2000 NUMBER	*	# N	1		
OTHER:	7.7	111	100	\	
DEMA DVS.		# 12 K	**	\ , 75m.	From STOCKETT
REMARKS:			و- ااين	$\Lambda$	Leon Places
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COUNTY CASCADE T. 15	<u> </u>	A	5 (EDW SEC TRACT & CAC
• 1 H • 1	**		
LAT, N. LONG	w.		UTM N E
TOWN SUBDIVISION			BLOCK LOT
OWNER'S NAME Felix MENGHIA	vi		ADDRESS BOX 62 STOCKETT
	_		•
	PHONE N	UMBER_	YEAR
2010			
ALT. LAND SURF. AT WELL MISL 3818 ft.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 32 M.	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD	FROM	TD	DESCRIPTION
STATIC WATER LEVEL* BELOW LSD R.	0	25	CLAY LOOSE ROCK
YIELD IN GALLONS PER MIN.	25	30	LOOSE SANDSTONE
HOW TESTED TIME (HR.)	30	32	
IF F, SHUTHN PRESS. IN PSI	-50		Clay
GEOLOGICAL SOURCE OF H <sub>2</sub> O AY			
Милим			
CASING DIA. 6 In. FROM ft. TO ft.			
in. FROM ft. TO ft.			
CASING TYPE STEEL			
PERFORATED INTERVAL			
ft. TO ft.			
ft. TO ft.			
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE JET PUMP			
DATE WELL COMPLETED 9/1/79			
HOW DRILLED SIBIC BY WHOM SIGNIFIED LIC. 64			
WELL USE DOMESTIC			
SOURCE OF INFO: WELL APPROPX_			
DRILLER OWNER USGS SCS			
OTHER			
Vac			
HAS WELL LOCATION BEEN VERIFIED YES			
DATE VERIFIED 404/82			
MEAS, POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
SWL* BELOW LSD			
YIELD IN GPM			
WATER TEMP. C 8.3° (184/82			
SPECIFIC COND. at 25°C 228 (104/82)			
MBMQ FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WG LAB. NUMBER			7.46 SHETCH MAP
SYS 2000 NUMBER	1	1 7	Tai-MP
OTHER:	1-17-		
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REMARKS:	LITT.	ш	11.75 m. from Steepest
			8 1
			29
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COUNTY CASCADE T. 10						
O 1 H O 1	" w.	UTM	и	ε		
TOWN SUBDIVISION .			BLOCK	LOT		
OWNER'S NAME MARY BOTH JACO	BES	ADDRESS	BeIT MT.			
	PHONE NUA	ABER	YEAR			
ALT. LAND SURF. AT WELL MSL 4240 H.		LITH	HOLOGIC LOG			
TOTAL DEPTH BELOW LSD 90 m.	INTERVAL	. (FT.)				
STATIC WATER LEVEL® BELOW LSD #1.	FROM	то	DESCRIPTION			
2 (		<del></del>				
HOW TESTED TIME (HR.)						
IE E CHITAN ODESS IN DEI		<del></del>				
OFOLOGICAL SOURCE OF H.O. CAMP CONC						
GEOLOGICAL SOURCE OF H20 CAMP (FONC						
CASING DIA						
ft. TOft.						
CASING TYPE						
PERFORATED INTERVAL ft. TO ft.						
ft. TO ft.						
PERFORATION DESC.						
PUMP SIZE (HP.) TYPE SUBMERSPOLE	ļ					
DATE WELL COMPLETED						
HOW DRILLED						
WELL USE DOCKT C F TOCK	-					
			· · · · · · · · · · · · · · · · · · ·			
SOURCE OF INFO: WELL APPROP.						
ORILLER OWNER USGS SCS			· <del>- · · · · · · · · · · · · · · · · · · </del>			
OTHER:						
HAS WELL LOCATION BEEN VERIFIED Yes		<del></del>				
BY WHOM HERMAN MODEL AGENCY MOME				-		
DATE VERIFIED 6/07/82			<del></del>			
				·		
MEAS. POINT ABOVE LSD ft. DATE TOTAL DEPTH BELOW LSD ft						
PUMPING LEVEL BELOW LSD			<del></del>	· · · · · · · · · · · · · · · · · · ·		
SWL* BELOW LSD ft			<del></del>			
YIELD IN GPM						
WATER TEMP.°C 79 4/07/92						
SPECIFIC COND. at 25°C 528 6/07/82						
MBMG FILE NUMBER						
ONR FILE NUMBER						
WELL FORM NUMBER						
MBMG WQ LAB. NUMBER	ستعلنات		SKETCH MAP			
SYS 2000 NUMBER		1 10	smu couler			
OTHER:	//					
		N	Y 1.			
REMARKS:	لتلخلنا			. 1		
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SUBOIVISIO	N		BLOCK	LOT
WHER'S NAME DUALEE		AC	DORESS	
	PHONE NI	MBER	YEAR	
LT. LAND SURF. AT WELL MSL 4380	ft. INTERVA		LITHOLOGIC LOG	
			DESCRIPTION	
IMPING LEVEL BELOW LSO	1.70	то		
ELD IN GALLONS PER MIN.			No Lug	
OW TESTED TIME (HR.)				
F, SHUT-IN PRESS. IN PSI				
EOLOGICAL SOURCE OF HO KOOTE MAL				
FORMATION				
	-			
ASING DIA In. FROM ft. TO	1 (			
In. FROM ft. TO	1			<u>-</u>
ASING TYPE				
ERFORATED INTERVAL ft. TO	n.			
n. TO				
ft. TO	ft.			
ERFORATION DESC.	_			
UMP SIZE (HP.) TYPE				
ATE WELL COMPLETED				
OW DRILLED				
Y WHOM LIC				
ELL USE	_			
OURCE OF INFO: WELL APPROP.				
RILLER OWNER USGS SCS				
THER	_	+		
AS WELL LOCATION BEEN VERIFIED	_			
WHOM TO OS BOLDE AGENCY 148AL	6			
ATE VERIFIED	_	-		
IEAS. POINT ABOVE LSD ft. DATE				
OTAL DEPTH BELOW LSO ft	_			
UMPING LEVEL BELOW LSD ft				
WL BELOW LSO 23.32 m. 8-19-4	<u> </u>			
TELD IN GPM	_			
VATER TEMP. C	_			
PECIFIC COND. at 25°C 506 2-19-	12			
IBMG FILE NUMBER				
NR FILE NUMBER	_			
VELL FORM NUMBER	_			
MBMG WQ LAB. NUMBER			SKETCH MAP	
YS 2000 NUMBER	-		1 To ket	1
OTHER:	31-		1 stacken	1 1
			7 10-	1 1
REMARKS: 5,C, 39300 /3,7°C	_ ::::::::	ш		
= 505.6 @ 25°C				
	_		House	C-11
F - FLOWING			0 1	

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COUNTY	_ Nors	R	TENW SEC. TRACT CADE
0 1 11 0 1			
LAT N. LONG	w.		UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME TO ENTRE TOTAL			ADDRESS SAND LOULEE /
50116 1 1 10017 TON 3 - 4 1			
	PHONE	IUM BER	YEAR
ALT. LAND SURF. AT WELL MSL 3660 ft.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD M.	FROM	то	DESCRIPTION
STATIC WATER LEVEL® BELOW LSD 30 ft.	<del></del>	5-	
TIELD IN GALLONS PER MIN.	- (2	3	· rolestone
HOW TESTED _ C TIME (HR.)	,	7	( ) NOT NE
IF F, SHUT-IN PRESS. IN PSI	,	/2	141 5/0:5
GEOLOGICAL SOURCE OF H20 / 10/			J_ & 1
		-7	
A Company of the Comp		45	101, 7005
CASING DIA In. FROM ft. TO ft.		42	157.45
In. FROM ft. TO ft.			INLE-SUE
CASING TYPE		65	S P.E.R. S. C.
PERFORATED INTERVAL 75 ft. TO 77 ft.	0		_ /- 55 -3
ft. TO ft.	,5	1	· / // 5.75// -
ft. TOft.	110	173	1 5 6 6 5 4
PERFORATION DESC.	- )	-	INDESTADE
PUMP SIZE (HP.) TYPE		253	CARENSIA
DATE WELL COMPLETED	117	295	T.WES-DUE: JAIK-DE KAL-1.
HOW DRILLED 65 1. 15		29%	LINE COURT
BY WHOM TONDESCALE CHE LIC.	-	-55 -03	+
WELL USE 5-01-	30	243	( MEE- NE
SOURCE OF INFO: WELL APPROP.	304	72	LATTORE EROUN TANK TOUT
DRILLER OWNER USGS SCS	336		CANT -
OTHER:		130	L'MESTONE EXCLUSION TOUR TERE
4=5			- 2 - 3 0 E EX 7
HAS WELL LOCATION BEEN VERIFIED 45	-		
DATE VERIFIED - 3 3 9	-		
	Tot	mal +	3302
MEAS. POINT ABOVE LSD ft. DATE	<del></del>	7.77	
TOTAL DEPTH BELOW LSDft.			
PUMPING LEVEL BELOW LSD ft.		i	
SWL* BELOW LSD ft		!	
YIELD IN GPM			
WATER TEMP. C			<u> </u>
SPECIFIC COND. at 25 C	-		
MBMG FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER		1	/ , SKETCH MAP
MBMG WQ LAB. NUMBER		, , , , , , , , , , , , , , , , , , ,	ñ !-!
SYS 2000 NUMBER	The state of the s	7	ar d
OTHER:		1	
DEMORNE. SCALARIL ALLES			
REMARKS: COMENTAL ARCHIT			1500
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NN	SUBDIVISION _				BLOCK _	LOT
MER'S NAME GORDON & V						
NEWS WORK SEPTEMBER						R
	244	PHONE	IUM BE R			
	<u>3420 n.</u> 	INTERV		LITHOLOG	IIC LOG	
	/36 n.		1		DESCRIPTION	•
ATIC WATER LEVEL BELOW LSD		FROM	то			
ELD IN GALLONS PER MIN.	15	0	20	SAND.	SILT	
OW TESTED BAILER TH	AE (HO)			GIACIAL		
E CHITTAN DOESE IN DEL		120	1/3/	WATER B	PARING	SANDSTONE
EOLOGICAL SOURCE OF H <sub>2</sub> O	VACTORIO			W.7111_E		
2)	2					
SING DIA. 6 In. FROM 0 1	TO /20 n.					
In. FROM ft						
ASING TYPE STEEL						
REFORATED INTERVAL ft						
	. то п.					
	. TO ft.					
REPORATION DESC.						
JMP SIZE (HP.) TYPE						
ATE WELL COMPLETED JA N.						
OW DRILLED CABLE						
YWHOM THOMAS FRANKLIN	LIC. 84					
ELLUSE DOMESTIC - LAWN						
OURCE OF INFO: WELL APPROP. X						
RILLER DWNER USGS_	scs					
THER:						
AS WELL LOCATION BEEN VERIFIED	<u> </u>					
IV WHOM HERMON MORE AG	ENCY MBMG					
ATE VERIFIED 6/09/82			<u> </u>			
IEAS. POINT ABOVE LSD				1		
OTAL DEPTH BELOW LSD				1		
IMPING LEVEL BELOW LSO						
WL* BELOW LSD	_ n					
IELO IN GPM						
ATER TEMP. C /3	6/09/82					
PECIFIC COND. at 25°C 2339	6/09/52					
BMQ FILE NUMBER						
NR FILE NUMBER						
ELL FORM NUMBER				1		
BMG WQ LAB. NUMBER			, A	, u	KETCH MAP	
YS 2000 NUMBER		1:1:1:		234	, /	
THER:		12-	Lie V	4	$t_{2}$	
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EMARKS:			1:1	سنبل	110.00	
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LAT N. LONG	w.		U1M		
TOWN SUBDIVISION _				BLOCK	LOT
Talle Patha				STACKOTT	M
OWNER'S NAME JOHN PEJKO			ADDRESS .	BOXEDA STA	MT. 59480 P.RT. SANOCA
	PHONE	TOM BE IT			
ALT. LAND SURF. AT WELL MSL 3482 M.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD 72 H.	INTERV	AL (FT.)	) [		
PUMPING LEVEL BELOW LSD  STATIC WATER LEVEL® BELOW LSD  YIELD IN GALLONS PER MIN.  50	FROM	то	-	DESCRIPTION	
STATIC WATER LEVEL BELOW LSD ft.					
VIELD IN GALLONS PER MIN		2_	TOP		
HOW TESTED TIME (HR.)	_2	16		IN SANDY	
IF F, SHUT-IN PRESS. IN PSI	16	47		BROWN CA	
GEOLOGICAL SOURCE OF H20 MOAR SON	47	58		N SANDSTON	
	.58	70	GRAY	GREEN St	IDIE
/ 6		<del> </del>			···
CASING DIA. Sin. FROM H. TO H.		<del> </del>	-		
5%in. FROM <u>49</u> ft. TO <u>70</u> ft.	-				
CASING TYPE	ļ	ļ			
PERFORATED INTERVAL ft. TO ft.		<del> </del>			
ft. TO ft.	-	<del> </del>	<del></del>		
ft. TO ft.		<del> </del>	+		
PERFORATION DESC.		<del> </del>			
PUMP SIZE (HP.) TYPE SUB.		<del> </del>	<del> </del>		
DATE WELL COMPLETED 2/26/1978			<del> </del>		
HOW DRILLED CARLE	-	1			
BY WHOM PAT BYRNE LIC. 318		<del> </del>			
WELL USE DOMESTIC (NUNOGARDY)		<u> </u>	<del>                                     </del>		
SOURCE OF INFDI WELL APPROP.		<u> </u>			
ORILLER OWNER USGS SCS		†			
OTHER:		·		· · · · · · · · · · · · · · · · · · ·	
HAS WELL LOCATION BEEN VERIFIED YES		1			
BY WHOM HELMIN MODE AGENCY M.B. M.G.		1	<b>†</b>		
DATE VERIFIED 6/04/82		T:			
MEAS. POINT ABOVE LSD ft. DATE			1		
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft					
SWL* BELOW LSD		1			
YIELD IN GPM					
WATER TEMP. °C 7.9 (64/82		1			
SPECIFIC COND. at 25°C 222 6/04/82					
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		_ ^	11 300	SKETCH MAP	
5YS 2000 NUMBER			λ	(2)	7)
OTHER:			091	. 121	ソ
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REMARKS:		1 .			
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• 1 и • 1 LAT N. LONG	w.		UTM	N	E
TOWN SUBDIVISION					
OWNER'S NAME RICHTRO KATALA			ADORESS	SANI JOU	11 /
	PHONE P	IUMBER.		YEAR	
ALT, LAND SURF, AT WELL MISL 3440 H.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW USD 158 R.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD n.	FROM	то	1	DESCRIPTION	
STATIC WATER LEVEL* BELOW LSO ft.					
YIELD IN GALLONS PER MIN.	0		Gazi	A: DR.F-	. غومد و
HOW TESTED E.A ED TIME (HR.) 3	ر د	1725		xx	
IF F SMUTAN PRESS IN PSI		147		" KIE	
GEOLOGICAL SOURCE OF H20 MADISON	147	158	1 JIME	5.700€	
LIMES-DWE		-			
47	1001	17RF	3293		
CASING DIA. 2 In. FROM 0 R. TO 47 R.	1	T TO THE	12017		
in. FROM ft. TO ft. CASING TYPE JECN (2016)	-				
PERFORATED INTERVAL					
		<del>                                     </del>			
ft. TO ft.	i				
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED 7.3-64					
HOW DRILLED CABLE TOOL					
BY WHOM JUOMA: FRANKLIN LIC.					
WELL USE DOMESTIC					
SOURCE OF INFO! WELL APPROP.					
DRILLER OWNER USGS SCS					
OTHER:					
HAS WELL LOCATION BEEN VERIFIED YES		ļ			
BY WHOM W. BENJAMIN AGENCY MENG	-				
DATE VERIFIED 6-9-82		-			
MEAS. POINT ABOVE LSO ft. DATE			ļ		
TOTAL DEPTH BELOW LSO ft			1		<del></del>
PUMPING LEVEL BELOW LSD	-		<del></del>		
SWL BELOW LSO 1010 M. C/4/22					
YIELD IN OPM		<del> </del>	<del> </del>		
WATER TEMP. C /3/1 G/(/22			<del>                                     </del>		
SPECIFIC COND. at 25 C // / / / / / / / / / / / / / / / / /		<b>†</b>			
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		- 11	J	SKETCH MAP	
5YS 2000 NUMBER		$\square T$	_	LURELL	
OTHERI	18	4		-T-71-XAC	7
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478 9 /3.1°C			,		
AS a SI OWNERO			/	(	C-15
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COUNTY	<b>3</b> (		EDOW SEC. TRACT NACE
COUNTY T	Nors	R	EOW SEC. TRACT
0 1 H 0 1	**		UTM N E
LAT N. LONG	w.		UTM N E
TOWNSUBDIVISION _			BLOCK LOT
OWNER'S NAME = YELYN A LYMAN			ADDRESS SAME TO EL ME
	PHONE N	UMBER_	YEAR
ALT, LAND SURF, AT WELL MSL			
7		A1	LITHOLOGIC LOG
3.0	INTERV	AL (FT.)	DESCRIPTION
STATIC WATER LEVEL® BELOW LSD #1.	FROM	то	DESCRIPTION
	5	20	TOF 5016
VIELD IN GALLONS PER MIN. HOW TESTED TIME (HR.)	20	30	GUMRG
IF F, SHUT-IN PRESS. IN PSI	30	40	SANLSTONE GRAVE,
	40	58	SAUL STONE
GEOLOGICAL SOURCE OF H20 Turcas 516 uncl. 14.	58	60	SMALE
	60	70	PRELETINESH TE EXNLETANS
CASING DIA TO SE M	.25	3-	MARD SHALE
CASING DIA In. FROM ft. TO ft.	77	126	Yessow Rus- 1 SANESTAIN
CASING TYPE			3 CENTONITE
PERFORATED INTERVAL 126 ft. TO 131 ft.	126	131	SANDS-ONE
n. TO n.			
fi. TOfi.			
PERFORATION DESC.			
PUMP SIZE (HP.) TYPE			
DATE WELL COMPLETED			
BY WHOM FOR CHIEF LIC. 135			
BY WHOM FOR CUPINE LIC. 135			
WELL USE CONSTITUTE			
SOURCE OF INFO: WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHER:			
1/2			
HAS WELL LOCATION BEEN VERIFIED 155	·		
BY WHOM NIETTEN AGENCY MENS			
DATE VERIFIED 6-9-82			
MEAS, POINT ABOVE LSO ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSD ft.			
SWL* BELOW LSO ft.	<u> </u>		
WATER TEMP. C /1/72			
SPECIFIC CONO. at 25°C 2207 6/4/82			
MBMG FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER			SKETCH MAP
SYS 2000 NUMBER			y /
OTHER:	12-	1 Je 1	
		1	
REMARKS: 1/1 1/1 1/1 5/7 / 6	LHIII.		
170×10 8 12.5°C			<i>i</i> 1
			C-16
•F = FLOWING			NIMEEK
MBMG Form 182 (9/79)		10.	SINEN

INTY CACCADE T. Z	Z. Pors	R	/ No or W	SEC. <u>73</u> T	RACT AAL
e I H e I	w.		UTM	N	Ε
SUBDIVISION				STARRT.	LOT
				STAR RT.	2. 7
R'S NAME MIKE KAVULLA			ADDRESS _	IND Confee	_/?(
				YEAR	
2////					
AND SURF. AT WELL MSL 3440 ft.		AL (FT.)	_	.ogic Log	
DEF THE DECOME OF		AL (F 1.)		DESCRIPTION	
IG LEVEL BELOW LSD	FROM	TO		5230111	
WATER LEVEL BELOW LSO ft.	10	90	(/40	+ 6000 JEN	
IN GALLONS PER MIN.		-	7 - , ,	STONE	
STED BALLER TIME (HR.) LORIN		14.5	F-11-7E		
JT-IN PRESS. IN PSI					
CAL SOURCE OF H <sub>2</sub> O MAJION	-	-			
////d1.0N					
		7.0.2	1775		
Z in. FROM n. TO/30_ n.	3	17/12	0.70		
in. FROM n. TO n.					
I RON		-			
NTERVAL ft. TO ft.	-				
n. TO n.					
п. то п.					
DESC					
OMPLETED (0/20/55					
MPLETED					
CHURN DEUI					
F. C. Flood LIC.	-				
Donestic	-	+			
FOI WELL APPROP.		+	+		
OWNER USGS SCS	-	+	+		
			+		
~		+	-		
ATION BEEN VERIFIED	-	+			
ERMON MORKPAGENCY MB MG		+	1		
0 6/10/82		<del></del>	<del> </del>		
BOVE LSD ft. DATE		<del></del>			
ELOW LSOft		<b></b>	-		
BELOW LSD ft					
n					
c 12.2 6/10/52					
0 11.00					
D. et 25 C // 64 6/19/82					
UMBER					
UMBER					
A NUMBER		<u> </u>	11.	3) SKETCH MAP	
LAB. NUMBER	[]	7	16.1	ソ	
UMBER			1-	TIRINY	
	7	n 1	11-		
	للتلنا	للل	/ //	VE vell	
		/	/	Viano Cili	
			.0	IN LANDIO	101
		10 350	SIC	17-1-1	Jen C-1
NG .		ر. ۲.	-		
182 (9/79)				1 \	

COUNTY ASCASE T. 19	La or s	R.	4 a or w	SEC. <u>/3</u>	TRACT 4.83
0 1 11 0 1					
LAT N. LONG	w.		UTM	N	ε
TOWN SUBDIVISION _				BLOCK	LOT
OWNER'S NAME Steppelypch			ADDRESS _	STAD COULE	= 30x 7/
J					
	PHONE N	UM BE R		YEAR	1455
2427)					
ALT. LAND SURF. AT WELL MSL 3430 11. TOTAL DEPTH BELOW LSD 468 11.	10.75.01			rogic rog	
	INTERV	AL (FT.)	4	DESCRIPTION	
PUMPING LEVEL BELOW LSD ft.  STATIC WATER LEVEL® BELOW LSD ft.	FROM	то		DESCRIPTION	
YIELD IN GALLONS PER MIN.			No	106	
HOW TESTEO TIME (HR.)				<u> </u>	
IF F, SHUT-IN PRESS. IN PS1			20 parte	-1 to be in	Medina.
			7	stone - owne	
GEOLOGICAL SOURCE OF H20 MADISON LIMESTAL					
CASING DIA In. FROM ft. TO ft.					
in. FROM ft. TO ft.					
CASING TYPE					
PERFORATEO INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TOft.					
PERFORATION DESC.			ļ		
PUMP SIZE (HP.) TYPE			ļ		
DATE WELL COMPLETED ONE SO THEY COLD					
HOW DRILLED			<del> </del>		
BY WHOM LIC			ļ		
WELL USE			<del> </del>		
SOURCE OF INFO; WELL APPROP.			ļ	<del></del>	
DRILLER OWNER USGS SCS	-		<del> </del>		
OTHER:					
HAS WELL LOCATION BEEN VERIFIED Tes					
BY WHOM TOSSENE AGENCY MEN'S					
DATE VERIFIED 6 /8 82			<u> </u>		
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft	-		<u> </u>		
PUMPING LEVEL BELOW LSO ft.	-				
SWL BELOW LSO 16.18 4. 6-16-82	-				
YIELD IN GPM			1		
WATER TEMP. C			<del> </del>		
3 Ec. 16 COND. 47 25 C					
MBMG FILE NUMBER					
ONR FILE NUMBER			<del> </del>		
WELL FORM NUMBER			<del></del>	EMETCH MAR	1
MBMG WQ LAB. NUMBER 42 90504				SKETCH MAP	( -1
SYS 2000 NUMBER			4	/	100.9
OTHER:	/3-			/	\.
REMARKS: Cours 10/12/2 cater quelity				/	
" c & Gulenyanie, has alway pur			1	/	
				/ / 0	1
\$4. M.					
F - FLOWING				JOHONE	C-18
MBMG Form 182 (9/79)					\
				*	

COUNTY <u>CASCADE</u> T. /		4 (E) or W	sec. 13	TRACT AADB
0 1 H 0 1 LAT N. LONG	w.	UTM	N	ε
TOWN SUBDIVISION			BLOCK	LOT
OWNER'S NAME GEORGE SOHA		AODRESS _	-FNP -3	-186
	PHONE NUMBER		YEAR	
ALT. LAND SURF. AT WELL MIL 3440 M.		LITHOL	oaic Loa	
TOTAL DEPTH BELOW LSD 2/2 H.	INTERVAL (FT.	.)		
PUMPING LEVEL BELOW LSD ft.	FROM TO		DESCRIPTION	
STATIC WATER LEVEL* BELOW LSD ft.				
YIELD IN GALLONS PER MIN.				
HOW TESTED TIME (HR.)				
GEOLOGICAL SOURCE OF H20				
GEOLOGICAL SOURCE OF H20		1		
MARINON		<del> </del>		
		+		
CASING DIA				
PERFORATED INTERVAL ft. TO ft.				
n. TO n.		1		
n. TO n.		<b>†</b>		
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED		1		
HOW DRILLED				
BY WHOM LIC				
WELL USE				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER USOS SCS				
OTHER: MIKE KAVUILA				
juli Light Jeripotini				
HAS WELL LOCATION BEEN VERIFIED Yes				
BY WHOM HERMAN MOOR & AGENCYMEMG				
DATE VERIFIED//0/92				
MEAS. POINT ABOVE LSD It. DATE				
TOTAL DEPTH BELOW LSD ft				
PUMPING LEVEL BELOW LSD ft				
SWL* BELOW LSD				
YIELD IN OPM				
WATER TEMP. C /2" 6//0/82				
SPECIFIC COND. at 25°C 6/9 6/10/82				
MBMG FILE NUMBER				
ONR FILE NUMBER				
WELL FORM NUMBER				
MEMG WQ LAB. NUMBER		JANY 7	SKETCH MAP	
SYS 2000 NUMBER	<b>→</b>	\(\frac{\f}{}		
OTHER:	13	11:0		
	W	_ /:-		
REMARKS	م لنتتتنا ر	27)	16AMIN	27 5
	V.	13/	.\/	
	.0 .	311-1	X X	(
	injec		Numar	C-19
*F * FLOWING	Co. Ex		MITH Jesey	•
MBMG Form 182 (9/79)	(6		1. 7	1.01 - No. 11/1.

COUNTY CASCADE	т/	190000	R	4 EOFW	sec. <u>13</u>	_ TRACT AAD
O 1 11 N. LONG	o 1	w.		UTM	N	Ε
TOWN	SUBDIVISION				BLOCK	LOT
OWNER'S NAME	ENTSI	31NGC	PR.	ADDRESS	SAND COL	1) ec MT.
		PHONE !	NUMBER,		YE	AR
ALT. LAND SURF. AT WELL MSL	3440 m.			LITHO	LOGIC LOG	
TOTAL DEPTH BELOW LSD	185 m.	INTER	AL (FT.)			
PUMPING LEVEL BELOW LSD	150 m.	PRUM	то		DESCRIPTI	ON
STATIC WATER LEVEL* BELOW LSD			//	- 1		
	20	10	10		5011	
HOW TESTED TIM		10	30	Yellow	Sandy CI	AY lows
IF F, SHUT-IN PRESS. IN PSI		30	39	SAND,	GRAVEL, L	JATER WITH
GEOLOGICAL SOURCE OF H20//	re Clone	3.0	/2 -	SOFF	ellow Cl	Ay.
PEREN MA	14120M	39	/22		_S. 1T	
	/	/22	147		UN SAND	
CASING DIA. 22 In. FROM ft			152		UN SANK	
22 in. FROM 43 ft		152	154			OSTONE AND
CASING TYPESTEE!		1				ANDWATER
PERFORATED INTERVAL ft	. TO ft.	1.54	157	BROG	IN SANI	2
	. то ћ.		160	SOFT	BROWN	CIAY
	. TOft.	1 / /	168	BROG	JN SAND	AND WATER
		168	185	BROKE	en lines	TONC SAND
PUMP SIZE (HP.) TYPE						INTER
DATE WELL COMPLETED 6/5/	101				(40 GPM	
HOW DRILLEDCABIC						1,
BY WHOM _ PAT BYENG			<del>                                     </del>	<u> </u>		
WELL USE DOMESTIC						
SOURCE OF INFD: WELL APPROP.						
DRILLER OWNER USGS_	scs		1	· · · · · · · · · · · · · · · · · · ·		
OTHER:			1			
	V - 4			<del> </del>		
HAS WELL LOCATION BEEN VERIFIED				<del> </del>		
BY WHOM HERMAN MOORE AGE	ENCY [13]					
DATE VERIFIED 6/08/92						
MEAS, POINT ABOVE LSD	ft. DATE		ļ			
TOTAL DEPTH BELOW LSO	_ ft					
PUMPING LEVEL BELOW LSD	_ ft	-				
SWL* BELOW LSO	_ ft		ļ	1		
YIELD IN GPM	6/22/82					
WATER TEMP.°C	1/08/52					
SPECIFIC COND. at 25 C	6/22/82					
MBMG FILE NUMBER	7					
DNR FILE NUMBER						
WELL FORM NUMBER						
MBMG WQ LAB. NUMBER					SKETCH MAP	
SYS 2000 NUMBER			A		11 - 10	AIN Elevations
OTHER:		1 1 2	1	well	(1227) 1 GR	11/10 - / 2011
5 · · · · · · · · · · · · · · · · · · ·		7		4	Ja 7/ 11.	Ber
REMARKS: /C CANING ON P.	10MBING		$\square$ N	110	1.1	
Lingime, old well				1	1	ich
Tal				118	1 7	
			Larlee	1	<b>F</b>	- BIRINGTON
*F = FLOWING			cheer			MORTHERI
MBMG Form 182 (9/79)				. / \	١,	0.30
MOREG FUITH 104 (9/18)		ENTS	HOUSE		VTo center	sile " "

OUNTY CASCADE T.	Nors	R	1 PHW SEC. 13 TRACT A
• 1 H • 1			UTM NE
WHER'S NAME GEORGE KRYULLA			ADDRESS
	PHONE N	UMBER.	YEAR
T. LAND SURF. AT WELL MIL			LITHOLOGIC LOG
OTAL DEPTH BELOW LSD 328 m.	INTERV	AL (FT.)	
MPING LEVEL BELOW LSO n.	FROM	то	DESCRIPTION
MATIC WATER LEVEL® BELOW LSO			
ELD IN GALLONS PER MIN.	0	73	
OW TESTED TIME (HR.)	20	67	CLAY
F SHUT-IN PRESS, IN PSI	67	83	SHALE
EOLOGICAL SOURCE OF H20 MADISON	53	105	
LIMESTONE	65	124	
	1 2 2	241	
ISING DIA In. FROM O_ R. TO 53 R.			IMBEDDEL FLINTASIK
in. FROM ft. TO ft.	241	32E	INTERMITTENT SANISTING
SING TYPE			ELMESTONE WATER
REPORTED INTERVAL			
ft. TO ft.	2 34 2	MAP	+3336
		1	
INFORATION DESC. TYPE ELEC. SUBMICES.			
MP SIZE (HP.) TYPE 2260, 000 (CE.)			
ATE WELL COMPLETED 7-30-60		<del>                                     </del>	
OW ORILLED _ ROTARY		<del>                                     </del>	
Y WHOM LIC	-	<del> </del>	
ELL USE DOMESTIC	<del></del>	<del> </del>	
DURCE OF INFO: WELL APPROP.	-	<del>                                     </del>	
RILLER OWNER USGS SCS	-	<del> </del>	
THERE			
//		<del></del>	
AS WELL LOCATION BEEN VERIFIED		-	
WHOM WISENSAMIN AGENCY MENG			
ATE VERIFIED 6-4-82		<del></del>	
EAS. POINT ABOVE LSD ft. DATE		-	
OTAL DEPTH BELOW LSD ft		<del> </del>	
MPING LEVEL BELOW LSD ft			
VL* BELOW LSO 1		-	
ELD IN GPM 32 6/4/92		<del> </del>	
ATER TEMP. C 13.3°C 6-4-82	.	-	
ECIFIC COND. et 25°C 904 6-4-82		1	
MO FILE NUMBER			
NR FILE NUMBER		1	
ELL FORM NUMBER			
BMG WQ LAB. NUMBER			SKETCH MAP
YS 2000 NUMBER	12.10		BAZZ MENT OF MINE
THERI		4	
THEN			OF MUN LEUCH
REMARKS: 5-4. 331021/02		لتك	
68×10.9/33°C			
WIT STREE OF MASING PREVENTED			
CETTURE SWL			C-21
			C-21

F - FLOWING

COUNTY CACCADE T. 1	2 Dors	R.,	4 BOWN SEC. 13 TRACT DADB
o ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '	w.		UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME CHUCK PCO		_	ADDRESS BOX 94 STAR, RT. SAND CO
	PHONE N	IUMBER	YEAR
ALT. LAND SURF. AT WELL MSL 3457 H.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSD 175 m.	FROM	TO	DESCRIPTION
STATIC WATER LEVEL BELOW LSD 130 M.			
YIELD IN GALLONS PER MIN.		6	Tep Soil
HOW TESTED PURP TIME (HR.)		1.3.	Carlow Million Con Carlow
IF F, SHUT-IN PRESS. IN PSI	13	149	GROWN ANDSTANDA SOCE NO.
GEOLOGICAL SOURCE OF HO LINESIONE	49	67	and the first
mnd: on	67	76	Will PROMY SIG
7 ()	7.1	120	GRE TONGTONE
CASING DIA. Z In. FROM	15	126	For I serve and a server a server and a server a server and a server and a server and a server and a server a
In. FROM ft. TO ft.	1	7	Lieut Mchan ment
CASING TYPE STEEL	1/26-	17.19	Wr7-12 1 /08-173
PERFORATED INTERVALft. TOft.		<del>                                     </del>	
ft. TO ft.	TOP	MPD.	337/
PUMP SIZE (HP.) 2 TYPE TYPE			
DATE WELL COMPLETED 12/26/21			
HOW OBILLED			
BY WHOM STAT PARAJE LIC.			
WELLUSE DEIBESTIC			
SOURCE OF INFO! WELL APPROP.			
DRILLER OWNER USGS SCS			
OTHER:			
HAS WELL LOCATION BEEN VERIFIED TES		1	
BY WHOM HERMAN MOORE AGENCY MBAG			
DATE VERIFIED 6/05/82		<del></del>	
MEAS, POINT ABOVE LSD ft. DATE		<del> </del>	
TOTAL DEPTH BELOW LSD ft		<del> </del>	
PUMPING LEVEL BELOW LSD 11.		-	
SWL BELOW LSD 82.56 m. lefus/ 82	-	-	
YIELD IN GPM		+	
WATER TEMP. C	-	-	
SPECIFIC COND. at 25 C 3/3 6/0 5/82		<del> </del>	
MBMG FILE NUMBER		+	
DNR FILE NUMBER		<del> </del>	
WELL FORM NUMBER			100 KETCH MAP
MBMG WG LAB. NUMBER		A	(32)
OTHER:			Dunner stren
		1:1	
REMARKS:		ے لتك	
		- y UN	
		ric.	\ / \
		باداد	C-22
*F - FLOWING		<b>4</b>	
MBMG Form 182 (9/79)			Transporter ville

COUNTY CASCADE T. /	7 Wors	R	9 COW	sec. <u>19</u>	TRACT DALA
0 1 H 0 1	PT				
LAT N. LONG	w.	(	UTM	N	E
TOWN SUBDIVISION				BLOCK _	LOT
OWNER'S NAME SAND COULEE WATER	USER.	<u>s</u> ,	ADDRESS S	1.01 200	ILE, MT
	PHONE N	IUMBER_		YEAF	
ALT. LAND SURF. AT WELL MIL 3680 H.			LITHOLO	010100	
TOTAL DEPTH BELOW LSD 210 M.		AL (FT.)		GIC LOG	
PUMPING LEVEL BELOW LSD				DESCRIPTION	
STATIC WATER LEVEL® BELOW LSD	FROM	то			
YIELD IN GALLONS PER MIN.	0	3	SURFI	nce	
HOW TESTED TIME (HR.)	5	10		-UNC	
IF F, SHUT-IN PRESS. IN PSI	10	/3	SUACE		
•	13	16		STONE	
GEOLOGICAL SOURCE OF H2O	16	20	SHALE		
	3 8	52	SAND	570NE	
CASING DIA & In. FROM O R. TO 34 R.	52	68	SHALLE		
In. FROM ft. TO ft.	68	70	SANC.	STONE_	
CASING TYPE	70	76	SHAL	€	
PERFORATED INTERVAL ft. TO ft.	76	81		STONE	
ft. TO ft.	0.	63	SURC	C	
n. TO n.	4 4 7	120	SANIS	TONE (YE	ιιοω
PERFORATION DESC.	120	/33			
PUMP SIZE (HP.) TYPE	/33	192	SAND.	STONE (W	ATER
DATE WELL COMPLETED 2-15-60	192	195	SHALE	LOCK &	11-E
HOW DRILLED	195	198	CIRY		
BY WHOM LIC	196	2/0	SANDS	TONE (WA	78.8
WELL USE					
SOURCE OF INFO! WELL APPROP.					
DRILLER OWNER USQS SCS					
OTHER					
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM W. BENJAMIN AGENCY MEMG					
DATE VERIFIED 6-5-82					
MEAS, POINT ABOVE LSD N. DATE					
TOTAL DEPTH BELOW LSD ft					
PUMPING LEVEL BELOW LSD ft					
SWL* BELOW LSD					
YIELD IN OPM					
WATER TEMP. C //. 6 6/6/12					
SPECIFIC CONO. M 25°C 8/4 6/5/82			_		
MOMO FILE NUMBER			-		
ONR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER			•	KETCH MAP	
SYS 2000 NUMBER		111	10		
OTHERI	111111	1	1	/	
	1111111		ر میں اسلام	1	
REMARKS: WELL #2			/ I SWATER	- X50°	II all the
576 340 8221'C		,	'		
59x10&11,6°C		1	10/1	/	
		<u></u>	//		C-23
*F * FLOWING		/.	//		
MBMG Form 182 (9/79)		5			
		/			

COUNTY CASCALE		_	R	4 (EMW	sec. <u>/4</u>	TRACT DADC
LAT N. LONG	0 1	" w.	•	UTM	_ N	E
TOWN	SUBDIVISION _				BLOCK	LOT
OWNER'S NAME SAND ZOULEE	WX-ER U	ISER.	5	ADDRESS	JAND COU	U.E. 11-
		PHONEN	IUMBER_		YEAF	
	3680 n.			LITHOLO	GIC LOG	
1 - 1 - 1 - 1 - 1 - 1 - 1	210 m.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	n.	FROM	то		DESCRIPTION	•
	/50 m.	0	8			
	65 GFM.		<del></del>		5016	(11, -, -)
HOW TESTED BALER TIME		8			KEN ROCK	
IF F, SHUT-IN PRESS. IN PSI		27	<del></del>		-ENGREY	
GEOLOGICAL SOURCE OF H20 MORRE	50~	40	48		, SANCET.	
E ANK	370 NE	48	53		WN SHALL	
		53	30		4 SANES	
CASING DIA. 5 18 In. FROM H. T		38	20		SHALE	
In. FROM ft. T		70			4 5MALE	
CASING TYPE IRON		24	87		BLACK ;	
PERFORATED INTERVAL ft. T		67	120		SANDY S.	
#. T		120	128		4 SANOST	
n. T	ro n.	128	135			MESTONE
PERFORATION DESC.		135	184		7 5ANOS	
PUMP SIZE (HP.) TYPE		184	197			DNE - 3346
DATE WELL COMPLETED 10-11-7	3	187	210	BLAC	K CLAY-	SHACE -
HOW DRILLED						
BY WHOM FA- BYRNE			-			
WELL USE SAND COUIEE WATER	SUPPLY					
SOURCE OF INFO: WELL APPROP.						
DRILLER OWNER USGS						
OTHER: ININM TAL PRES S	5. C. W. V.)					
HAS WELL LOCATION BEEN VERIFIED	7E S		-			
BY WHOM J. GENTAN A AGEN	CY MEMG					
DATE VERIFIED 5-5-82		-				
MEAS. POINT ABOVE LSD	t. DATE					
TOTAL DEPTH BELOW LSD f	t					
PUMPING LEVEL BELOW LSD f	t		-			
SWL* BELOW LSD f	t	-				
YIELD IN GPM						
WATER TEMP. C			-			
SPECIFIC COND. at 25 C						
MBMG FILE NUMBER						
DNR FILE NUMBER						
WELL FORM NUMBER						
MBMG WQ LAB. NUMBER			1	J	KETCH MAP	
SYS 2000 NUMBER			<del>    </del>			
OTHER:			<del>[]]</del>		>	CINI SOLER
REMARKSI WELL = 1				المرازين -	~	
				>/	,	
			(	11		
F = FLOWING						C-24
MBMG Form 182 (9/79)			1			

COUNTY CASCADE		_	R	4 Oarw	SEC	TRACT DCC
AT N. LONG.	• 1	w.		UTM	N	Ε
OWN	SUBDIVISION _				BLOCK	LOT
WHER'S NAME CHARLES	FRANTZIO	-4		ADDRESS _	SANO CO	ULCE, MT.
		PHONE N	UMBER_		YE.	AR
LT. LAND SURF. AT WELL MSL	3650 n.			LITHO	LOGIC LOG	
OTAL DEPTH BELOW LSD	<i>∞</i> //(2	INTERV	AL (FT.)		DESCRIPTION	ON.
TATIC WATER LEVEL BELOW LSD _		FROM	то			
TELD IN GALLONS PER MIN.	/ 3	$\Box$	112.	6/600	- GUMOOI	na en sol
HOW TESTED EALL TIM	IE (HR.)	1125	1/6	00	Lid umel	₹ =
F. F. SHUT-IN PRESS, IN PSI						
DEOLOGICAL SOURCE OF H <sub>2</sub> O	m 00N					
	11)					
ASING DIA In. FROM ft.						
in. FROM ft.	TO ft.	-				
ASING TYPE		-				
ERFORATED INTERVAL ft.				<del></del>		
	TO ft.	1			<del></del>	
n.	TO ft.			<del> </del>		
ERFORATION DESC.						
UMP SIZE (HP.) TYPE						
ATE WELL COMPLETED						
OW DRILLED						
у wном						
VELL USE						
OURCE OF INFO: WELL APPROP.						
RILLER OWNER USGS_		-				
THER:						
AS WELL LOCATION BEEN VERIFIED	1/2 3					
W WHOM W. BENJAMIN AGE	MRMI					· · · · · · · · · · · · · · · · · · ·
WHOM STORY AGE	NCY ZIE					
DATE VERIFIED 6-3-82			<del>                                     </del>			
EAS. POINT ABOVE LSD	ft. DATE	-				
OTAL DEPTH BELOW LSD	n					
UMPING LEVEL BELOW LSD	n					
WL BELOW LSD	n					
TELO IN GPM						
VATER TEMP. C PECIFIC COND. IL 25 C PECIFIC COND. IL 25 C	6-3-82					
PECIFIC COND. at 25°C 1047	1-3-82					
ABMQ FILE NUMBER						
ONR FILE NUMBER						
VELL FORM NUMBER						
IBMO WO LAB. NUMBER			===	1	SKETCH MAP	
YS 2000 NUMBER				12	102.0	
OTHER:		-12			-1-	
		T			)	11.100
DEMARKS: 571 3290 20,50	c			/		LOU FE
REMARKS: <u>571 3290 20,5°.</u> 74×10 0 10.5°C			-)	(		
1,7.00,70.0			(		-)'	
	<del></del>					
E - ELOWING					/	C-25
F = FLOWING					/	

MBMG Form 182 (9/79)

( ) 15: 01:	0.0		_	21	Deco
COUNTY CASCADE T. 1	7 (Nors	R. 4	EDW SEC	C/ TRAC	TUCCO
0 ' " 0 ' LAT N. LONG	**		N	_	
N. LONG.	w.	OTM:	N		
TOWN SUBDIVISION _				жк ч	.от то.
OWNER'S NAME CHARLES E. MARKE		ADDR	ESS DAND	Coulter	<del>/2: /</del>
	PHONE NUM	DER		YEAR	
ALT. LAND SURF. AT WELL MSL 3830 H.		L	ITHOLOGIC LOG		
TOTAL DEPTH BELOW LSD ~ 150fe H.	INTERVAL	(FT.)			
PUMPING LEVEL BELOW LSD ft.	FROM 1	то	DESCR	IPTION	
STATIC WATER LEVEL* BELOW LSDft.					
YIELD IN GALLONS PER MIN.	-				
HOW TESTED TIME (HR.)					
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF H2O	<b></b>	/	V2 200		
•					
		<del></del>	01101100		
CASING DIA In. FROM ft. TO ft.		-+	VAILAB	( =	
In. FROM ft. TO ft.		<del></del>			
CASING TYPE				<del></del>	
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.	-	<del></del>			
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					
HOW DRILLED					
BY WHOM LIC				-	
WELL USE DOMEST C					
SOURCE OF INFO; WELL APPROP  ORILLER OWNER USGS SCS					
OTHER:				<del></del>	
HAS WELL LOÇATION BEEN VERIFIED YES		_			
BY WHOM W. BENJAMIN AGENCY MEMO					
DATE VERIFIED 4-4-82					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSDftft.				•	
PUMPING LEVEL BELOW LSDft.					
SWL+ BELOW LSO ft					
YIELD IN GPM					
WATER TEMP. C /3.4 6-4-92					
SPECIFIC COND. at 25 C 9/5 6-4-82					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		$\sim$	SKETCH MA	•	
SYS 2000 NUMBER		1	3 3		~~
OTHER:		1	ريقن		7 Co
2		$\wedge$	( )	WELL	
REMARKS: (-) 31 321.10	لتلتلتك	5			
C1.69×109 13.4°			( )	GOATI	i
Wate Level No - Ala CEIT			,		
			(		C-26
*F = FLOWING					J = 0
MBMG Form 182 (9/79)					

SUBDIVISION  WNER'S NAME SCROLD NARTZENB  LT. LAND SURF. AT WELL MSL  OTAL DEPTH BELOW LSD  FATIC WATER LEVEL® BELOW LSD  FATIC WATER LEVEL® BELOW LSD  OW TESTED BRILLER  TIME (HR.)  EF, SHUTHN PRESS. IN PSI  EOLOGICAL SOURCE OF H20  ASING DIA STEEL (10 GB/F2)  ERFORATED INTERVAL  IN. TO  R. TO  THE  ERFORATION DESC.  JUMP SIZE (HR.)  TYPE  ATE WELL COMPLETED  1/-/2-73  OW ORILLEO  CABLE 7004	FROM  7 75 22 25 36 50 59	/AL (FT.)  TO  / /5 22 25 32 36 50 57 //2	VEAR  LITHOLOGIC LOG  DESCRIPTION  LOOSE CINL ROCK  REL SHALE  JAN  HARL SINLESINE  REI SARE  HIRC SINLESINE  RED SARE  GRAY SIRLE
LT. LAND SURF. AT WELL MSL  DTAL DEPTH BELOW LSD  DMPING LEVEL BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TO R.  SELD IN GALLONS PER MIN.  OW TESTED ANCER TIME (HR.)  EF, SHUTHN PRESS. IN PSI  ECOLOGICAL SOURCE OF H20  ASING DIA. Source of H20  ASING TYPE STELL (10 46/Ft)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JMP SIZE (HP.) TYPE  ATE WELL COMPLETED 11-12-73  OW DRILLED ABLE 7004	FROM  7  75  22  25  36  50  59	/AL (FT.)  TO  /5  25  32  36  50  57  //2	LITHOLOGIC LOG  DESCRIPTION  LOGSE CHAL ROCK  REL SHALE  JUAN  HARL SHALE  RET SHALE  HARD SHALET HE  GRAY SHALE  HARD SHALE  HARD SHALE  JOHN SHALE
DITAL DEPTH BELOW LSD  DIMPING LEVEL BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TO R.  SELECTION TO R.  SELECTION OF THE CHR.)  ASING DIA. Source of H20  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TO R.  TO R.	INTERV FROM  1 15 22 25 31 36 50 59	/AL (FT.)  TO  / /5  22  25  32  36  50  57  // 2	DESCRIPTION  LOOSE EINL ROCK  REL SHALE  JLAY  HARL SHALLTONE  REL SHALE  WILL SHALLTONE  REL SHALLTONE  REL SHALE  HARD SHALE  HARD SHALE  JOHN SHALE
DITAL DEPTH BELOW LSD  DIMPING LEVEL BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TO R.  SELECTION TO R.  SELECTION OF THE CHR.)  ASING DIA. Source of H20  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TO R.  TO R.	1NTERV FROM (1) (2) (2) (2) (2) (3) (3) (4) (5) (7) (7) (7) (7) (7) (7) (7) (7) (7) (7	10 15 22 25 36 50 57 112	DESCRIPTION  LOOSE EINL ROCK  REL SHALE  JLAY  HARL SHALLTONE  REL SHALE  WILL SHALLTONE  REL SHALLTONE  REL SHALE  HARD SHALE  HARD SHALE  JOHN SHALE
DITAL DEPTH BELOW LSD  DIMPING LEVEL BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TATIC WATER LEVEL® BELOW LSD  TO R.  SELECTION TO R.  SELECTION OF THE CHR.)  ASING DIA. Source of H20  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TIME (HR.)  TO R.  TO R.	1NTERV FROM (1) (2) (2) (2) (2) (3) (3) (4) (5) (7) (7) (7) (7) (7) (7) (7) (7) (7) (7	10 15 22 25 36 50 57 112	DESCRIPTION  LOOSE SIND ROCK  RED SHALE  JLAY  HARL SINDSTONE  RED SHALE  GRAY SHALE  HARD SINDSTONE YANGO  JOHN WATER
ASING DIA SIELE (10 46/F4)  ERFORATION DESC.  UMPING LEVEL BELOW LSD  770  R.  770  770	FROM  ()  7  75  22  25  33  36  50  59	10 15 22 25 36 50 57 112	DESCRIPTION  LOOSE SIND ROCK  RED SHALE  JLAY  HARL SINDSTONE  RED SHALE  GRAY SHALE  HARD SINDSTONE YANGO  JOHN WATER
TATIC WATER LEVEL® BELOW LSD 770 ft.  IELD IN GALLONS PER MIN.  OW TESTED BAILER TIME (HR.) 7  F, SHUTHN PRESS. IN PSI 10  EOLOGICAL SOURCE OF H20 ft. TO 74 ft.  In. FROM ft. TO ft.  ASING DIA 5 ft. FROM ft. TO ft.  ASING TYPE 5 TELL (10 46/Ft) ft. TO ft.  ALL FROM ft. TO ft.  ALL FROM ft. TO ft.  ERFORATION DESC.  UMP SIZE (HP.) TYPE  ATE WELL COMPLETED 7/-/2-73  OW DRILLED 6 ABLE 7004	22 25 32 36 50 59	/ /5 22 25 32 36 50 57 //2	RED SHALE  JUNY  HARL SINDSTONE  RED SHALE  HARD SINDSTONE  RED SHALE  HARD SINDSTONE ************************************
ASING DIA B In. FROM O 11. TO 14 11.  ASING DIA B In. FROM 11. TO 14 11.  In. FROM 11. TO 11. TO 11.  ASING TYPE STEEL (10 46/Ft)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JUMP SIZE (HP.) TYPE  ATE WELL COMPLETED 11-12-73  OW DRILLED ABLE 7004	1 15 22 25 32 36 50 59	25 32 36 50 57 112	RED SHALE  JUNY  HARL SINDSTONE  RED SHALE  HARD SINDSTONE  RED SHALE  HARD SINDSTONE ************************************
OW TESTED BRICER TIME (HR.)  F, SHUT-IN PRESS. IN PSI  EOLOGICAL SOURCE OF H <sub>2</sub> O  ASING DIA. 8 In. FROM 0 11. TO 1/4 11.  In. FROM 11. TO 11.  ASING TYPE STEEL (10 6/FE)  ERFORATED INTERVAL 11. TO 11.  PERFORATION DESC.  JUMP SIZE (HP.) TYPE  ATE WELL COMPLETED 1/1-/2-73  OW DRILLED CABLE 7004	75 22 25 33 36 50 59	25 32 36 50 57 112	HARL SINDSTONE  RET STATE  HIND SINDSTONE  RED STATE  GRAY STATE  HARD SONDSTONE 9 FINE  I OFM WATER
ASING DIA. Source of H20 R. TO A. TO	22 25 35 36 50 59	25 32 36 50 57 112	HARL SINDSTONE  RET STATE  HIND SINDSTONE  RED STATE  GRAY STATE  HARD SONDSTONE 9 FINE  I OFM WATER
ASING DIA. Source of H <sub>2</sub> O	25 35 36 50 59	35 36 50 57 112	REL SARGE HAND SANDSTARE RED SAR E GRAY SARLE HARD SANDSTONE YRITED I OPM WATER
ASING DIA B In. FROM O 11. TO 14 11.  — In. FROM 11. TO 11.  ASING TYPE STEEL (10 6/FE)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JUMP SIZE (HP.) TYPE  ATE WELL COMPLETED 1/1-12-73  OW DRILLED CABLE 7004	35 36 50 59	36 50 57 112 135	HILL CHARSTONE  RED SHE E  GRAY SHELE  HARD SONDSTONE YELLOW  I GEM WATER
In. FROM 1. TD 1.  ASING TYPE STEEL (10 66/F2)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JUMP SIZE (HP.) 179E  ATE WELL COMPLETED 11-12-73  OW DRILLED CABLE 7004	36 50 59	50 54 112 135	RED SHALE  GRAY SHALE  HARD SANDSTONE YATTAG  JOHN WATER
In. FROM 1. TD 1.  ASING TYPE STEEL (10 66/F2)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JUMP SIZE (HP.) 179E  ATE WELL COMPLETED 11-12-73  OW DRILLED CABLE 7004	50 59	54 112 135	GRAY SHALE HARD SANDSTONE YATTAGE JOHN WATER
In. FROM 1. TD 1.  ASING TYPE STEEL (10 66/F2)  ERFORATED INTERVAL 11. TO 11.  ALCO 11. TO 11.  ERFORATION DESC.  JUMP SIZE (HP.) 179E  ATE WELL COMPLETED 11-12-73  OW DRILLED CABLE 7004	50 59	112 135	HARD SANDET OF Y FIND
ASING TYPE STEEL (10 46/FE)  ERFORATED INTERVAL 11. TO 12.  ALCO 12.  THE TO 12.  THE TO 14.  THE TO 14.  THE TYPE 17.  ATE WELL COMPLETED 11. TO 2.  TO 12.  TYPE 17.	59	135	I GAM WATER
ERFORATED INTERVAL	1/2	135 135	I GAM WATER
ALCON TO THE TOPE TO TOPE TO THE TOPE TO T	1/2	135	SRAY SYALE
PERFORATION DESC.  UMP SIZE (HP.)  ATE WELL COMPLETED //-/2-73  OW OBJULEO CABLE 7004	135	1.5	
ATE WELL COMPLETED 11-12-73  OW ORILLED CABLE 7004			SOFT CANLLYDIE
OW ORILLED CABLE 7004		16€	KEE SHELF
ATE WELL COMPLETED 11-12-73		125	CLAY M XED WITH CALL
OWDRILLED CABLE TOOL	220	248	MORRISON EANIETEN.
OW DRILLED			WYTELL OF APPRIX = OF
Y WHOM THOMAS B. FRANKLIN LIC. 84			WE 12 - COP, 9 248
FLL USE DOMESTIC			
OURCE OF INFO: WELL APPROP.			
RILLER OWNER USQS SCS			
		1	
THER:			
AS WELL LOCATION BEEN VERIFIED 755	-		
Y WHOM U. BENZAMIN AGENCY MBMG			
ATE VERIFIED 6 2 82		1	
		<u> </u>	
OTAL DEPTH BELOW LSD ft			
UMPING LEVEL BELOW LSD ft			
WL* BELOW LSD ft			
TELD IN OPM			
ATER TEMP. C			
PECIFIC COND. at 25 C		<b>†</b>	
IBMG FILE NUMBER			
NR FILE NUMBER		†	
ELL FORM NUMBER		-	SKETCH MAP
IBMG WG LAB. NUMBER	[ ] · [	<b>1</b>	
YS 2000 NUMBER	1	# 11	N SANGER
THER:	+ + :	11 '	
EMARKSI CUPER NOULDN - MILOW ME	7	1:1	<u></u>
TO TAKE SWL			1.66
			,

0 I H 0 1	11			эт <u> 331</u>
LAT N. LONG	w.	·	JTM N E	
TOWN SUBDIVISION _			BLOCK	LOT
OWNER'S NAME HARYEY LAKS : 30			Sout 30115	= 11
OWNER'S NAME MARKET MAR	, ,		ADDRESS	- , ,
	PHONE N	UMBER	YEAR	
ALT. LAND SURF. AT WELL MSL 3680 H.  TOTAL DEPTH BELOW LSD 700 H.			LITHOLOGIC LOG	
	INTERV	AL (FT.)	0.540.51571011	
PUMPING LEVEL BELOW LSO	FROM	то	DESCRIPTION	
YIELD IN GALLONS PER MIN.				
HOW TESTED TIME (HR.)				
IF F, SHUT-IN PRESS. IN PSI				
GEOLOGICAL SOURCE OF H2O	-			
	-		1 2	
			1/10/200	
CASING DIA. 💪 In. FROM #. TO #.			CIR LAFLE	
In. FROM ft. TO ft.			FIELLE	
CASING TYPE			£17.	
PERFORATED INTERVAL ft. TO ft.	L			
tt. TO tt.				
ft. TO ft.			· · · · · · · · · · · · · · · · · · ·	
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
HOW DRILLED				
BY WHOM LIC				
WELL USE				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER USGS SCS				
OTHER:				
HAS WELL LOCATION BEEN VERIFIED 755				
BY WHOM J. RENTLU AGENCY MBMG				
DATE VERIFIED 6-3-5				
MEAS. POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSOft.	-			
PUMPING LEVEL BELOW LSD ft.	-	+		
SWL* BELOW LSO #				
YIELD IN GPM				
WATER TEMP. C		<del> </del>		
SPECIFIC COND. at 25 C (27 6 1782		-		
MBMG FILE NUMBER				
ONR FILE NUMBER				
WELL FORM NUMBER				
MBMG WQ LAB. NUMBER	باللثا	A	SKETCH MAP	
SYS 2000 NUMBER				
OTHER:		<del>                                     </del>	7	u'.
A / 202				
REMARKS: 27/ 7348 4,2°C		لتا	<u> </u>	
J~ > 9/4 2°:	•			

MBMG Form 182 (9/79)

0 I H	a 1 H	w.		UTM	_ N	E
TOWN					BLOCK	LOT
OWNER'S NAME SERIOLD SWI	AN TELNETA	ミ人		ADORESS 💆	1.11 .211	: 1.7
OWNER STROME						
	PHC	NE N	UMBER_		YEAR	
ALT, LAND SURF, AT WELL MSL	3775 n. 586 n. IN			LITHOLO	aic Loa	
TOTAL DEPTH BELOW LSD	586		AL (FT.)		DESCRIPTION	
PUMPING LEVEL BELOW LSO STATIC WATER LEVEL® BELOW LSD		MOI	то			
	5 16	Ç	3	-/	7. 10.00	
VIELD IN GALLONS PER MIN.  HOW TESTED FUMP TIME		Ž	5		Spirit	
	E (HK.)	5	19	( 25 Y C	1- EXLLON	,
IF F, SHUT-IN PRESS. IN PSI		15	7.3		11 -11	
GEOLOGICAL SOURCE OF H20		<i>j</i> .	24		SIPEF	
	2510 0 100	2.4	4-7		SIALE	
E Madison		39	55		SHALE	
CASING DIA 5/3in. FROM n.	1 .	5.5	53			
in. FROM ft.	10 11.			121	SIALE	
CASING TYPE 2-26 (STELL)		<u>-</u>	75		E ME	
PERFORATED INTERVAL ft.	10 · · · · —	5	78		w SANIS-	
NONE n.	то п. 7	' '5	147		CARIE	
THE WE	TO ft/	47	175		SHALE	
PERFORATION DESC.	ر ا	75	178	CREY	SLALE	
PUMP SIZE (HP.) TYPE		78	187	RED	SLICE	
DATE WELL COMPLETED _ 4-24-	75 /	87	177		SUPLE	
HOW DRILLED ALE ROTARY	/	97	230	GRE "	CANLSTON	1 - 1/1 -
HOW ORILLED AIR ROTARY BY WHOM A SEITH MEATEN	uc 2.75 2	30	239		(SIAI <)	
WELL USE DOMESTIC	2	39	250		, JANGE :	
		50	-115		SHALE	
SOURCE OF INFO: WELL APPROP.	<del>-</del>	15	456		Y SHEWT-SH	006-10
DRILLER OWNER USGS_		<u>56</u>	515		LIME (MA)	
OTHER:		<u> </u>				
	) <del></del>	/ 5	586		1 RILLING	
HAS WELL LOCATION BEEN VERIFIED	963			No mut	NO WATER A	5 6 6 6
BY WHOM W. BENTAMIN AGE	NCV MBM 3					15-506
DATE VERIFIED 6-2-82			1			
MEAS. POINT ABOVE LSD	n. DATE	1	1700	3:17		
TOTAL DEPTH BELOW LSD	n					
PUMPING LEVEL BELOW LSD						
SWL* BELOW LSD	n			1		
VIELD IN COM						
WATER TEMP. C	6-7-87					
0 / 2 /	(-)-8)					
SPECIFIC COND. at 25 C						
MBMG FILE NUMBER				1		
ONR FILE NUMBER						-
WELL FORM NUMBER					SKETCH MAP	
MBMG WG LAB. NUMBER				N	W	ink triff
SYS 2000 NUMBER			<del>   </del>		3/1	
OTHER:	!!	<b>=</b>	<del>       </del>			
				]		
REMARKS: JUNE WOULDN-	picew Li		نــا	7	'	
"> -1-E CWL				44		
STL 771 8 2070C				-		
115 @13.1°C						C = 29

COUNTY PESCATE T. /	2 Nors	R	4 ENW SEC. 27 TRACT ACED
0 1 11 0 1	_		
LAT N. LONG	w.		UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME NICKMAN YOUNG			ADDRESS _ AND DULEE PT
FORTER OWER (MURRY M. SU-	- RE		
	PHONE	UMBER	YEAR
ALT. LAND SURF. AT WELL MSL 38 25 ft.  TOTAL DEPTH BELOW LSD 423 ft.			LITHOLOGIC LOG
	INTERV	AL (FT.)	
PUMPING LEVEL BELOW LSO ft.	FROM	TO	DESCRIPTION
STATIC WATER LEVEL® BELOW LSO	0	14	LLAY
YIELD IN GALLONS PER MIN.	14	22	REL GEL
HOW TESTED TIME (HR.)	22	24	SENDSTONE
IF F, SHUT-IN PRESS. IN PSI	24	29	
GEOLOGICAL SOURCE OF H20  (Cooleve) Fix and	23	4/	ELL BEI
1 Coneva   - A are	4	47	
	4.7	64	SMALE- GREY SOFT- REL BEL
CASING DIA In. FROM ft. TO ft.	64	09	
In. FROM ft. TO ft.	99		
CASING TYPE FOR	<del></del>	101	SINISTONE
PERFORATED INTERVAL ft. TO ft.	101	1/2	
n. TO h.	//2		
ft. TO ft.	/22		SINLETONE
PERFORATION DESC.	145	148	Since Kost
PUMP SIZE (HP.) TYPE ECOTIFIC	148	122	SHALE ROSE SCINESTONE
DATE WELL COMPLETED	. 63		RED BED
BY WHOM SOLVERSEN LANG LIC.	172		SANLY SLALE ROSK - 1/41)
BY WHOM SE VALLES & LETT NG LIC.	184		
WELL USE DOMESTIC	2/4		SANLY STALL ROOK
SOURCE OF INFO: WELL APPROP.	223		
DRILLER WOWNER WUSGS SCS	233		SANDSTONE & WATER - 5 GIM
OTHER:	245		
	253		PLUE SHALE ROCK
HAS WELL LOCATION BEEN VERIFIED 755			YELLOW SLACE ROCT
BY WHOM W. GENTAN " AGENCY MBMG	274		SHALE ROCK CONGLOMERATION
DATE VERIFIED 6-5-82	401	423	SANLSTONE
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSO ft.			
SWL* BELOW LSD ft.			
YIELD IN GPM			
WATER TEMP. °C			
SPECIFIC COND. at 25 C			
MBMG FILE NUMBER			
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER			SKETCH MAD FISHUL COULEE
SYS 2000 NUMBER		1	<b>N</b> N
OTHER:	1 . 1	<u> </u>	110005500
	1 11 11		
REMARKS: WELL WAS UNDER SPIER		لنا	11
N FIGORET FIRMINT 1/2 52, DR			Ti - Wecc
in. MARCAGIE			)
			C-30
*F = FLOWING			/
MBMG Form 182 (9/79)			

COUNTY CASCADE T. 15	_	R	<u>'</u> 4_(E)++	sec. 36	TRACT DEBA
AT N. LONG	" w.		UTM	N	E
TOWN SUBDIVISION .				BLOCK	LOT
OWNER'S NAME ROBERT KLASNE	°R		ADDRESS	Stockell	MT. 594
	PHONE N	NUMBER.		YEAR	
ALT. LAND SURF. AT WELL MISL 3625 M.				LOGIC LOG	
TOTAL DEPTH BELOW LSD 330 M.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD A 101 FUTTING H.	FROM	TO		DESCRIPTION	
STATIC WATER LEVEL BELOW LSD RL	-	2	7 0	c . /	
VIELD IN GALLONS PER MIN				Soil	
HOW TESTED AIR 13/0 WEN TIME (HR.)	1	14	C//	INITH GRAS	
F F, SHUT-IN PRESS. IN PSI	17	156	SHA	le	
DEOLOGICAL SOURCE OF H20	56	12.30	L1770	estone	2 42 44
Mad ion		-	430	APPROX 10	200
/ 🔀		<del> </del>	100	10-15 61	71
CASING DIA TIN. FROM n. TO n.	-	-	11/2		
in. FROM ft. TO ft.		<del>                                     </del>	11/1/2	x 506/M	
CASING TYPE STEEL		-	<u> </u>		
ERFORATED INTERVAL ft. TO ft.			<del> </del>		
n. TO n.		-			
ft. TO ft.		-	-		
ERFORATION DESC.		-			
PUMP SIZE (HP.) TYPE					
HOW DRILLED FORWACD ROTARY	-	-			
HOW DRILLED FORWACD ROTARY	-	-	ļ		
SY WHOM A26. DR. 11.NG LIC. 247		<del> </del>	<del> </del>		
WELL USE					
SOURCE OF INFO: WELL APPROP			ļ		
DRILLER OWNER USQS SCS					
OTHER:		-			
	1	-			
HAS WELL LOCATION BEEN VERIFIED Yes	-				. ,
BY WHOM HERMAN MOUNE AGENCY MBMG	-		<u> </u>		
DATE VERIFIED 6/01/82		-	<u> </u>		
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft			1		
PUMPING LEVEL BELOW LSD ft	-				
SWL . BELOW LSD #		-	1		
YIELD IN OPM		-	-		
WATER TEMP. C			-		
SPECIFIC COND. at 25°C		-	-		
MBMG FILE NUMBER	-	-	<del> </del>		
ONR FILE NUMBER		ļ			
WELL FORM NUMBER		<u> </u>	1		
MBMG WQ LAB. NUMBER	L-1			SKETCH MAP	
5Y5 2000 NUMBER		+ +	•	1-	
OTHER:	36-			CENTER-ILLE	
		+ /		/	
MEMARKS, MONIS DE GUDPING BY	LITT	N		ı	
Me and of July or			/		
			1		
DE A EL OWING			् ि	rin , er - re-se	C-31
*F = FLOWING MBMG Form 182 (9/79)	5	3	117	(AJ ₹ 11	
MDMG FUITH 104 (9//9/	۵/۰	-1.011	Y		

COUNTY CASCADE T. L		R. 50	SECT	MCT BDDC
AT N. LONG	w.	UTM _	N	E
OWN SUBDIVISION			BLOCK	LOT
WNER'S NAME GEORGE HEAL W	e11 3	ADDRE	ss SAND COSIEC	
	PHONE NU	MBER	YEAR	
ALT. LAND SURF. AT WELL MIL 3455 M.		LI	THOLOGIC LOG	
TOTAL DEPTH BELOW LSD 220 M.	INTERVA	L (FT.)		
UMPING LEVEL BELOW LSDft.	FROM	то	DESCRIPTION	
TATIC WATER LEVEL* BELOW LSD				
TELD IN GALLONS PER MIN.				
OW TESTED TIME (HR.)				
F F, SHUT-IN PRESS. IN PSI				
GEOLOGICAL SOURCE OF HO Well INTO I MESTINE				
TREAM 10' AWAY (1)				
CASING DIA. 6 In. FROM ft. TO ft.				
In. FROM ft. TO ft.				
CASING TYPE SCOL				
PERFORATED INTERVAL ft. TO ft.				
ft. TO ft.				
ft, TO ft.				
PERFORATION DESC.			· · · · · · · · · · · · · · · · · · ·	
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
HOW DRILLED				
BY WHOM LIC.				
WELL USE STOCK				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER X USGS SCS				
OTHER:				
HAS WELL LOCATION BEEN VERIFIED YES				
BY WHOM HERMAN MOORE AGENCY MBMG				
DATE VERIFIED 6/64/82				
MEAS. POINT ABOVE LSD				
TOTAL DEPTH BELOW LSD ft				
PUMPING LEVEL BELOW LSDft.				
swl+ BELOW LSD 71.				
YIELD IN GPM				
WATER TEMP.°C				
SPECIFIC COND. at 25°C 1667 6/04/82				
MBMG FILE NUMBER				
ONR FILE NUMBER	-	<del></del>		
WELL FORM NUMBER				
MBMG WQ LAB. NUMBER	المعلمات	7 /	A) SKETCH MAP	1
SYS 2000 NUMBER		H A (2)	<i>y</i>	les lower
OTHER:	7	7	y	To by Hen on
		귀 .! /	/	Well Tok
REMARKS:	GILLI	א ב		10 Po
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A 1208 -61		/\	1	
		/ `		C-32 Pro1
*F = FLOWING		/	teny	J
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COUNTY CASCADE			R	TROW	sec	TRACT _ EI
0 1 H		99				_
LAT N. LONG		w.		UTM	N	_ ε
TOWN	SUBDIVISION				BLOCK	LOT
T 5	L .					2 11
OWNER'S NAME JIM ERIC	RSON			ADDRESS	- AND LE	2/66/11.
		PHONE N	UMBER.		YEAR	
,	1162					
ALT. LAND SURF. AT WELL MSL	453 n. 214 n.				LOGIC LOG	
		INTERVA	AL (FT.)			
	n.	FROM	TO		DESCRIPTION	
STATIC WATER LEVEL* BELOW LSD	3 < ".					
TIELD IN GALLONS PER MIN.			-			
HOW TESTED TIME	(HR.)					
IF F, SHUT-IN PRESS. IN PSI	2 (7					
GEOLOGICAL SOURCE OF H20 LIME	23/22/6					
Man	11.501					
CASING DIA. 2 In. FROM ft. T		1 4				
in. FROM ft. T	10 ft.					
CASING TYPE 5/26/						
PERFORATED INTERVAL ft. T	ro n.			-		
n. T	ro ft.					
n. T	ro ft.					
PERFORATION DESC.						
PUMP SIZE (HP.) TYPE						
DATE WELL COMPLETED						
BY WHOM PHI GYRNE	LIC.					
WELL USE						
SOURCE OF INFO: WELL APPROP.						
DRILLER OWNER X USGS	scs					
OTHER:						
HAS WELL LOCATION BEEN VERIFIED	Yes					
BY WHOM HERMAN MORE AGENC	CY MAM/					
DATE VERIFIED 6/02/22						
· ·	2475					
MEAS. POINT ABOVE LSD ft				1		
TOTAL DEPTH BELOW LSD ft						
PUMPING LEVEL BELOW LSD ft						
SWL+ BELOW LSD ft	t		-			
YIELD IN GPM						
WATER TEMP. C						
SPECIFIC COND. at 25 C						
MBMG FILE NUMBER						
DNR FILE NUMBER						
WELL FORM NUMBER				L		
MBMG WQ LAB. NUMBER			-		SKETCH MAP	a hor
SYS 2000 NUMBER				^	INF coste e C	reer
OTHER:		7-	긤去	(2) X	INICO	
	_	1111111	IN (	1/1/11		
REMARKS: NOL 15 PART O	F		<u> </u>	///	TRACY	
TRACY WATER SUSTER WHICH MAS TWO	eM_			111		
WHICH MAS TWO	0115 100			MA	11961	
F - FLOWING			/		-H315C	
F - FLOWING				1,	I riplat His	e in Treet
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COUNTY LASCADE T. L		R.	Seor W SEC. 18 TRACT 3AC
o i ii	w.		UTM N E
OWN SUBDIVISION .			BLOCK LOT
WHER'S NAME ANDY TESINSKY			ADDRESS SAND CONTER MT.
7			YEAR
T. LAND SURF. AT WELL MIL 3460 M.			
185	INTERV	A. 15-7.1	LITHOLOGIC LOG
OTAL DEPTH BELOW LSD #1.  UMPING LEVEL BELOW LSD #1.  TATIC WATER LEVEL® BELOW LSD #1.	FROM	TO	DESCRIPTION
IELD IN GALLONS PER MIN.			
OW TESTED TIME (HR.)			
EOLOGICAL SOURCE OF H20 LINE 1000			
EUCOSICAL SOURCE OF M20 23111111			
ASING DIA. & In. FROM R. TO R.			
In. FROM ft. TO ft.			
ASING TYPE STECK			
ERFORATED INTERVAL ft. TO ft.			
п. то п.			
t. TO ft.			
ERFORATION DESC.			
JMP SIZE (HP.) TYPE			
ATE WELL COMPLETED			
OW DRILLED			
Y WHOM LIC			
ELL USE DOMESTIC			
DURCE OF INFO: WELL APPROP.			
RILLER OWNER X USGS SCS			
THER:			
AS WELL LOCATION BEEN VERIFIED YES			
Y WHOM HERMAN MORE AGENCY MBMG			
ATE VERIFIED		ļ	
EAS. POINT ABOVE LSD ft. DATE			
OTAL DEPTH BELOW LSD ft			
UMPING LEVEL BELOW LSD ft.			
NL BELOW LSD 48.68 M. 4/0/82			
IELD IN GPM			
ATER TEMP. °C (5.2 4/10/82		-	
PECIFIC COND. at 25°C 6/7 4/10/82	L	<b></b>	
BMG FILE NUMBER			<del> </del>
NR FILE NUMBER		-	
ELL FORM NUMBER	L	L	
BMG WQ LAB. NUMBER			PORTINGTON NORTHERN
YS 2000 NUMBER		H #	asali per or
THER:	18		16030
		<del>     </del>	El Do-well
REMARKS:	لنلنلن	النا	1
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		+	TA
F = FLOWING			Number Pura C-34
MBMG Form 182 (9/79)	-	127	
ADDRESS - AND THE SELECT	lans N	F-10-061	TARS

COUNTY CASCADE T. L.	Lon	R	5 Dorw	sec. <u>/8</u>	TRACT BURD
• 1 H • 1	w.		UTM	N	Ε
				D1 004	LOT
TOWN SUBDIVISION _					
OWNER'S NAME LARRY MCEWER				County ex	leo MT
OWNER'S NAME FARRY TICE WELL			ADORESS _	LARG CLO	
				VE	.R
	PHONE	NUMBER .			
ALT. LAND SURF. AT WELL MIL 3457 N.			LITHOL	OGIC LOG	
TOTAL DEPTH BELOW LSD	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD /55 ft.				DESCRIPTIO	N
STATIC WATER LEVEL® BELOW LSD	FROM	то			
VIELD IN GALLONS PER MIN. 40	2	20	TOP	011	
HOW TESTED BAILER TIME (HR.) 2	20	3.0	Yello	w SHAL	e
IF F, SHUT-IN PRESS. IN PSI	10	38		TONITE	
GEOLOGICAL SOURCE OF H20 LINE STONE	38	48		SHOLE	
MADUON MADUON	40	65		SAND RO	
	65	85		SHALE	
CASING DIA & In. FROM Q R. TO 162 R.	85	89		STONE	
	89	105			Hole + Land 17: ~C
CASING TYPE	105	110		NSHAIR	
PERFORATEO INTERVAL ft. TO ft.	110	11.5			pt-n( = pM)
	115	122		one Los	
ft. TO ft.		130		SAND ROCK	
PERFORATION DESC.	130	1776	,	11mc	
PUMP SIZE (HP.) TYPE	136	140	(pross		
DATE WELL COMPLETED 3/7/13	140	143	GUAR		
HOW ORILLED CHURN DRILL	143	147		GRAY SI	tale
BY WHOM PAT BYRNE LIC. 135	147	153	SANOS	Tore	
WELL USE DOMESTIC	153	162		STONE	
SOURCE OF INFO! WELL APPROP.				(406PM)	
ORILLER OWNER USQS SCS					
OTHER:					
	1. 7	1200	3354		
HAS WELL LOCATION BEEN VERIFIED Yes					
BY WHOM ELERMAN MODEL AGENCY MANG					
DATE VERIFIED 6/10/82					
MEAS, POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSO ft					
PUMPING LEVEL BELOW LSD ft.					
SWL* BELOW LSO ft					
YIELD IN GPM					
WATER TEMP. °C 11.7° (6/10/82					
SPECIFIC COND. at 25°C 634 6/10/82					
MBMG FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER		1			
MBMG WQ LAB. NUMBER		- 4		SKETCH MAP	
SYS 2000 NUMBER	141		Л	pacy	
OTHER:	19-	N	/ ^	211	
	1.0	111	14	3 / 10	
REMARKS: POTALLE TOSTE SINCE		لنذ	1		N MICH LEVEN
Cliniles ENTIMINGER'S old well			1 11	, )	-
CAJED IN.			िक्रिक्		
			(1)	74 1.7	continuen
F = FLOWING			1/4	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	C-35
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COUNTY CASCAde T. 1	9 (Nors	R.,	5 EOW SEC. 18 TRACT CRDD
0   H 0	w.		UTM N E
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME TERRY NET			ADDRESS BOX 95 STAR RT. STOCK
	PHONE I	NUMBER	YEAR
ALT. LAND SURF. AT WELL MSL 3455 N.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD		AL (FT.)	
PUMPING LEVEL BELOW LSD /72 m.	FROM	то	DESCRIPTION
STATIC WATER LEVEL BELOW LSD 12.			
YIELD IN GALLONS PER MIN.	0		TOP Soil
HOW TESTED TIME (HR.)	2		BROKEN SANDSTONE
IF F, SHUT-IN PRESS. IN PSI	20	35	Tellow CIAY
GEOLOGICAL SOURCE OF HOD MADISON	36	40	SAND STONE
LMESTONE	40	49	Yellow CIAY
2 / // -	49	54	Broken SANdsTone
CASING DIA. 2 In. FROM	59	64	Broken SANDSTONE
( in. FROM 100 ft. TO 175 ft.		1	Broken Grey SAND STONE
CASING TYPE	67	70	
PERFORATED INTERVAL ft. TO ft.		100	GREE SHALE
n. TO n.			HARA GREY limesTone
ft.	105	125	11Mestoke
PERFORATION DESC.		<del>                                     </del>	
PUMP SIZE (HP.) TYPE	<del></del>	<del> </del>	
DATE WELL COMPLETED		<del> </del>	
HOW DRILLED		<del> </del>	
WELL USE DOMESTIC RESTOCK		<del>                                     </del>	<u> </u>
WELL USE DOMOSTIC CONSTITUTE		<del> </del>	<del></del>
SOURCE OF INFO: WELL APPROP.		<del>                                     </del>	
DRILLER OWNER USGS SCS			<del> </del>
OTHER:	<del></del>		<u> </u>
HAS WELL LOCATION BEEN VERIFIED		1	
BY WHOM HELDEN MORE AGENCY MRMG			
DATE VERIFIED 6/05/82			
MEAS. POINT ABOVE LSD ft. DATE			
TOTAL DEPTH BELOW LSD ft.		T	
PUMPING LEVEL BELOW LSO 172 m. 4057 PZ		1	
SWL BELOW LSD 79.76 m. 6/19/82			
YIELD IN GPM //.25 6/19/82			
WATER TEMP. °C /2.5 L/05/82			
SPECIFIC COND. at 25°C 597 1/19/82			
MBMG FILE NUMBER			
DNR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER			1 A TO TOPLY SKETCH MAP
SYS 2000 NUMBER			2/ 1 1/
OTHER:	1/2-	## T	MUMBER SPURN
		1:1 1.	RUNHINGTON NORTHAN
REMARKS:	تلتلتا	٣, ١	KURHAGION NORITION
		70	
		_	
			1 DHOUSE C-36
*F = FLOWING			\ \ \ \ \
MBMG Form 182 (9/79)			
			ITO CENTERVILLE

SUBDIVISION  SUBDIVISION  SUBDIVISION  BLOCK  LOT  ADDRESS SALV SECS  WHERE'S NAME  FULLY MARK O  ADDRESS SALV SECS  FHONE NUMBER  VEAR  LITHOLOGIC LOG  INTERVAL (FT)  DESCRIPTION  TATIC WATER LEVEL' BELOW LSO  OF TATIC WATER LEVEL' BELOW LSO  IN. FROM  OF TATIC WATER LEVEL' BELOW LSO  IN. FROM  TO  THE FORM  TO  TO  TO  TO  TO  TO  TO  TO  TO  T	TOUNTY CASCADE T.	9 Apors	R.,	5 Garw	sec. 18	TRACT DEA
SUBDIVISION BLOCK LOT ADDRESS SALL STATE S		-				
WHER'S NAME  WHER'S NAME  WEAR  PHONE NUMBER  VEAR  VEAR  LITHOLOGIC LOQ  JUMPING LEVEL BELOW LSO  JUMPING LEVEL BELOW LSO  TATIC WATER LEVEL'S BELOW LSO  TATIC WATER LEVEL'S BELOW LSO  ASSING TYPE  JUMPING LEVEL BELOW LSO  ASSING DIA V. IN. FROM J. II. TO J. II.  II. FROM II. TO J. II.  JEFORATED INTERVAL.  III. FROM III. TO J. II.  III. FROM III. J. II.  III. FROM III. TO J. II.  III. FROM III. J. II.  III. FROM III. TO J. II.  III. FROM III. TO J. II.  III.	N. LONG.	ч.		UI#		
TITLE AND SURF, AT WELL MISL  OTAL OPPTH BELOW ISO  JANUARY DESCRIPTION  INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  DESCRIPTION  INTERVAL (PT.)  FROM TO  TIME (HR.)  ST. 170  INTERVAL (PT.)  FROM TO  TIME (HR.)  ST. 170  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  TO INTERVAL (PT	OWN SUBDIVISION				BLOCK	LOT
TITLE AND SURF, AT WELL MISL  OTAL OPPTH BELOW ISO  JANUARY DESCRIPTION  INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  DESCRIPTION  INTERVAL (PT.)  FROM TO  DESCRIPTION  INTERVAL (PT.)  DESCRIPTION  INTERVAL (PT.)  FROM TO  TIME (HR.)  ST. 170  INTERVAL (PT.)  FROM TO  TIME (HR.)  ST. 170  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  INTERVAL (PT.)  TO INTERVAL (PT.)  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  FROM TO  TO DESCRIPTION  INTERVAL (PT.)  TO INTERVAL (PT	WHER'S NAME KULY MARKO			ADDRESS	SAND LOS	
DISSERPTION  DESCRIPTION  TATIC WATER LEVEL'S BELOW LSD  TATIC WATER LEVEL'S BELOW LSD  TATIC WATER LEVEL'S BELOW LSD  TO  THE (HR.)  OW TESTED  TIME (HR.)  TO  TO  TO  TO  TO  TO  TO  TO  TO  T		PHONE P	NUM BE R		YEAR	
DISSERPTION  DESCRIPTION  TATIC WATER LEVEL'S BELOW LSD  TATIC WATER LEVEL'S BELOW LSD  TATIC WATER LEVEL'S BELOW LSD  TO  THE (HR.)  OW TESTED  TIME (HR.)  TO  TO  TO  TO  TO  TO  TO  TO  TO  T	NET. LAND SURF. AT WELL MIL 3455 H.			LITHO	Logic Log	
TATIC WATER LEVEL' BELOW LSD	OTAL DEPTH BELOW LSD	INTER	AL (FT.)			
IELD IN GALLONS PER MIN.  OW TESTED.  TIME (HR.)  F, SHUTTAN PRESS. IN PSI  EOLOGICAL SOURCE OF H <sub>2</sub> O	UMPING LEVEL BELOW LSO	FROM	TO		DESCRIPTION	
OW TESTED  OW TESTED  OW TESTED  TIME (HR.)  F, SHUTTAN PRESS. IN PSI  EOLOGICAL SOURCE OF H <sub>2</sub> O  MURLION  ASING DIA V In. FROM  II. TO  II. In. FROM  II. TO  II.  ASING TYPE  SEED  REFORATEO INTERVAL  II. TO  II.  II. TO  II.  R. TO  II.  R. TO  II.  REFORATION DESC.  JUMP SIZE (HP)  TYPE  AATE WELL COMPLETED  OW ORILLED  OW ORILLED  OW WHOM  MARTH T  UC.  ELL LUSE  FORMATION BEEN VERIFIED  OW HIND  OW HOME  AS WELL LOCATION BEEN VERIFIED  OW HOME  AS WELL LOCATION BEEN VERIFIED  OTAL DESTINATION  ON ALL THE BELOW LSD  II.  III.  III	TATIC WATER LEVEL BELOW LSO		1/3-	+		
F. SHUTAN PRESS. IN PSI  EOLOGICAL SOURCE OF H <sub>2</sub> O //P.P. STONE  MIRITION  ASING DIA V In. FROM In. TO In.  In. FROM In. TO In.  ASING TYPE STEEL  ERFORATED INTERVAL In. TO In.  In. TO In.  ERFORATION DESC.  UMP SIZE (IMP)  TYPE  ATE WELL COMPLETED  OWN OF INTERVAL  AND PRIZE (IMP)  TYPE  ATE WELL COMPLETED  OWN OF INTERVAL  AS WELL LOCATION BEEN VERIFIED YCS  WHOM //C/T/A) //Ocac Agency //A/I/C  AS WELL LOCATION BEEN VERIFIED YCS  WHOM //C/T/A) //Ocac Agency //A/I/C  ATE VERIFIED  AS WELL LOCATION BEEN VERIFIED YCS  WHOM //C/T/A) //Ocac Agency //A/I/C  ATE VERIFIED  AS WELL LOCATION BEEN VERIFIED YCS  WHOM //C/T/A) //Ocac Agency //A/I/C  ATE VERIFIED  AND ATE OF THE OWN AS IN DATE  OTAL DETTH BELOW LSD  IN.  WILL BELOW LSD  IN.  WILL BELOW LSD  IN.  MILTER TEMP C  DECIFIC CONO. It 2°C  SMG FILE NUMBER  BMG FILE NUMBER  BMG FILE NUMBER  BMG FILE NUMBER  BMG WG LAS. NUMBER  THERI  EMARKS:  WILL FORM NUMBER  THERI  EMARKS:  WILL TO MIND AND AND AND AND AND AND AND AND AND A	TELO IN GALLONS PER MIN.	100	733	1 1201		
ECLOGICAL SOURCE OF M <sub>2</sub> O MPP MAILLIAND  ASING DIA V In. FROM R. TO R.  III. FROM R. TO R.  ASING TYPE STACE  ERFORATED INTERVAL R. TO R.  R. TO R.  R. TO R.  ERFORATION DESC.  UMPS SIZE (HP) TYPE  ATE WELL COMPLETED / 940  OW ORILLED  VY WHOM MILED  VY WHOM MILED  VY WHOM MILED  YO WHOM MILED  YO WHOM MILED  YO WHOM MILE APPROP.  THE RI  AS WELL LOCATION BEEN VERIFIED C S  V WHOM MILED APPROP.  THE RI  AS WELL LOCATION BEEN VERIFIED C S  OTAL DETTH BELOW LSD  OTAL DETTHE BELOW LSD  O	OW TESTED TIME (HR.)	1 2 7	190	117963	1020	
ASING DIA V IN. FROM IN. TO IN.  ASING TYPE  STEAT  IN. TO IN.  IN	F F, SHUTHN PRESS. IN PSI			<del> </del>		
ASING DIA V IN. FROM IN. TO IN.  ASING TYPE  STEAT  IN. TO IN.  IN	EOLOGICAL SOURCE OF HO LINE SCONE		-	-		
ASING DIA V. IN. FROM	MILDION		<u> </u>	2 2 4		
IN. FROM N. TO N.  STEEL PROPORTED INTERVAL N. TO N.  N. TO N.  N. TO N.  N. TO N.  PL.			DAD	1527		
ASING TYPE  STEEL  REFORATED INTERVAL  R. TO	ASING DIA . In. FROM n. TO n.					
ASING TYPE  STEEL  REFORATED INTERVAL  R. TO	In. FROM ft. TO ft.		1	<u> </u>		
ERFORATED INTERVAL	ASING TYPE STEEL			İ		
TI. TO TI.  TI. TO TI.  TI. TO TI.  TH. TO TI.  TH. TO TI.  TYPE  ATE WELL COMPLETED  OW ORILLED  VELL USE POTENTIC SOCK  DURCE OF INFO! WELL APPROP.  RILLER OWNER X USQS SCS  THER!  AS WELL LOCATION BEEN VERIFIED  YE SOUND PROPER SOCK  ATE VERIFIED POR AGENCY MAN GOAR AGENCY MAN AG				1		
TI. TO TU  TO TU  TO TU  TO TU  TO TU  TYPE  ATE WELL COMPLETED  OW DRILLED  OW DRILLED  OW WHOM  THE TI  CUC.  COURCE OF INFO; WELL APPROP.  RILLER OWNER X USGS SCS  THER:  AS WELL LOCATION BEEN VERIFIED  O' WHOM  ATE VERIFIED  O'TAL DEPTH BELOW USD  OTAL DEPTH BELOW USD  TI.  WILL BELOW USD  TI.  BELD IN OPM  ATER TEMP, C  BEND FILE NUMBER  RELL FORM NUMBER  THER:  EMARKS:  EMARKS:  THER:  THER:  EMARKS:  THER:  THER:  EMARKS:  THERE  TH						
ERFORATION DESC.  JUMP SIZE (HP.) TYPE  ATE WELL COMPLETED  OW ORILLED  Y WHOM MERTH   LIC.  ELL USE LONGLE & YOUL  DURCE OF INFO! WELL APPROP.  RILLER OWNER WUSGS SCS  THER!  AS WELL LOCATION BEEN VERIFIED  ATE OF ALL WISG  ATE OF ALL WISG  ATE OF ALL WISG  ATE OF ALL WISG  BELOW LSD  ATE OF ALL WISG  ATE		1		1	1	
UMP SIZE (HP.)  TYPE  ATE WELL COMPLETED  (940)  OW ORILLED  V WHOM  (PAPEL L.C.  WELL USE COMPLE C SOUL  DURCE OF INFO! WELL APPROP.  RILLER OWNER X USQS SCS  THER!  AS WELL LOCATION BEEN VERIFIED  V WHOM (CRITIC) MODER AGENCY MANGE  ATE VERIFIED  (APP 2  LEAS, POINT ABOVE USD  OTAL DEPTH BELOW USD  OTAL DEPTH BELOW USD  IN.  INITIAL BELOW USD  IN.  INITIAL BELOW USD  R.  INITIAL BELOW USD  INITIAL BELOW USD  R.  INITIAL BELOW USD  INITIAL BEL			1	†		
ATE WELL COMPLETED  OW ORILLED  Y WHOM  MAPH  LIC.  ELL USE PORPAGE > SOCE  DURCE OF INFO; WELL APPROP.  RILLER OWNER X USGS SCS  THER:  AS WELL LOCATION BEEN VERIFIED  Y WHOM MARAN MORR AGENCY MANA  ATE VERIFIED  OTAL DEPTH BELOW USD  OTAL DEPTH BELOW USD  R.  UMPING LEVEL BELOW USD  R.  NL* BELOW USD  PECIFIC CONO, AI 25°C  DECIFIC CONO, AI						
OW ORILLED  Y WHOM		<del></del>		<del>                                     </del>	<del></del>	
WHOM PART LIC.  FILL USE POPERIC & SOCK  DURCE OF INFO; WELL APPROP.  RILLER OWNER X USGS SCS  THER:  AS WELL LOCATION BEEN VERIFIED YCS  Y WHOM PART MOORE AGENCY MANGE  ATE VERIFIED GARAN MOORE AGENCY MANGE  BEAS, POINT ABOVE LSD N. DATE  OTAL DEPTH BELOW LSD N. DATE  OTAL DEPTH BELOW LSD N. WITH BELOW LSD N. DATE  OTAL DEPTH BELOW L	DATE WELL COMPLETED			<del>                                     </del>		
PELL USE FORE TO F STOCK DURCE OF INFOI WELL APPROP.  RILLER OWNER X USQS SCS THERI  AS WELL LOCATION BEEN VERIFIED YCS Y WHOM MCRAMA MORR AGENCY MAME ATE VERIFIED GARRY  PEAS, POINT ABOVE LSD R. DATE OUTAL DEPTH BELOW LSD R.  UMPING LEVEL BELOW LSD R.  WIL' BELOW LSD R.  WILL FORM NUMBER  WAS FILE NUMBER  WYS 2000 NUMBER  THERI  WAS 2000 NUMBER  WYS 2000 NUMBER  THERI  WAS 2	HOW DRILLED		-	ļ		<del></del>
DURCE OF INFO; WELL APPROP.  RILLER OWNER X USGS SCS  THER:  AS WELL LOCATION BEEN VERIFIED  AS WELL LOCATION BEEN VERIFIED  Y WHOM /C/2/AN MOORE AGENCY MAME  ATE VERIFIED  GOTAL DEPTH BELOW LSD  TO THE SELOW L		-		<del> </del>		
RILLER OWNER X USGS SCS THER:  AS WELL LOCATION BEEN VERIFIED YCS Y WHOM MCIZMAN MOORE AGENCY MAME ATE VERIFIED G/B/R2  BEAS, POINT ABOVE LSD TH. DATE OTAL DEPTH BELOW LSD TH. DATE OTAL DATE OTAL DEPTH BELOW LSD TH. DATE OTAL	VELL USE COMESTIC & SIOCK		<del> </del>			
THERI  AS WELL LOCATION BEEN VERIFIED  Y WHOM (CRMA) MOORE AGENCY MBM &  ATE VERIFIED  GARL MARCH  ATE VERIFIED  GARL MARCH  THERI  TO DATE  TO DAT	OURCE OF INFO: WELL APPROP.		ļ	ļ		
AS WELL LOCATION BEEN VERIFIED Yes Y WHOM (CRAIN MOORE AGENCY/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1	ORILLER OWNER X USGS SCS		-			
AS WELL LOCATION BEEN VERIFIED Yes Y WHOM (CRAIN MOORE AGENCY/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1/1						
WHOM MORE AGENCY MR MG  ATE VERIFIED G/01/82  IEAS. POINT ABOVE LSD N. DATE  OTAL DEPTH BELOW LSD N.  UMPING LEVEL BELOW LSD N.  ILLO IN GPM  IATER TEMP. C 7.9 G/09/82  DECIFIC COND. M 25°C 527 L/09/82  DEMAG FILE NUMBER  PELL FORM NUMBER  THERI  EMARKSI  EMARKSI  EMARKSI  EMARKSI  C-3		į				
WHOM MORE AGENCY MR MG  ATE VERIFIED G/01/82  IEAS. POINT ABOVE LSD N. DATE  OTAL DEPTH BELOW LSD N.  UMPING LEVEL BELOW LSD N.  ILLO IN GPM  IATER TEMP. C 7.9 G/09/82  DECIFIC COND. M 25°C 527 L/09/82  DEMAG FILE NUMBER  PELL FORM NUMBER  THERI  EMARKSI  EMARKSI  EMARKSI  EMARKSI  C-3	AS WELL LOCATION BEEN VERIFIED TES					
ATE VERIFIED 6/08/82  BEAS. POINT ABOVE LSO	WWHOM HERMAN MOORE AGENCY MBMG	1				
THERI  TEAS. POINT ABOVE LSD  TH.  DATE  OTAL DEPTH BELOW LSD  TH.  DUMPING LEVEL BELOW LSD  TH.  WL* BELOW LSD  TH.  DIELD IN GPM  DATE  TATER TEMP. C  PECIFIC COND. M 25 C  DECLIFIC						
OTAL DEPTH BELOW LSD						
UMPING LEVEL BELOW LSD N.  WL* BELOW LSD N.  JELD IN GPM  WATER TEMP. °C /2.9 (69/82)  PECIFIC COND. 81 25°C 58.7 (408/82)  IBMG FILE NUMBER  WR FILE NUMBER  WELL FORM NUMBER  WELL FORM NUMBER  THERI  EMARKSI  F - FLOWING  TO A STATE OF THE NUMBER  THERI			T	1		
WL* BELOW LSD  IELD IN GPM  IATER TEMP. C  PECIFIC COND. St 25°C  527  L/08/82  IBMG FILE NUMBER  IRR FILE NUMBER  IELL FORM NUMBER  ISMG WQ LAB. NUMBER  YS 2000 NUMBER  THERI  EMARKSI  F - FLOWING  R.    100			<del> </del>	<u>†                                      </u>		
IELD IN GPM  PATER TEMP. C  12.9  G/09/82  PECIFIC COND. at 25°C  587  G/08/82  IBMG FILE NUMBER  PELL FORM NUMBER  PEND WQ LAB. NUMBER  PYS 2000 NUMBER  THERI  EMARKSI  EMARKSI  F - FLOWING  C-3			<del> </del>			
TATER TEMP. C  PECIFIC COND. At 25°C  527  L/08/82  IBMG FILE NUMBER  WELL FORM NUMBER  IBMG WQ LAB. NUMBER  YS 2000 NUMBER  THER:  EMARKS:  THER:  T			-			
PECIFIC COND. At 25°C 587 408/82  IBMG FILE NUMBER  WELL FORM NUMBER  WELL FORM NUMBER  VS 2000 NUMBER  THERI  EMARKSI  F - FLOWING  587 408/82  10	TELD IN GPM	-	+			
SEMG FILE NUMBER  NR FILE NUMBER  SELL FORM NUMBER  SIBMO WQ LAB. NUMBER  YS 2000 NUMBER  THERI  EMARKSI  F - FLOWING  SECTION OF THE NUMBER  1127  127  127  127  127  127  127  1		-				<del></del>
NR FILE NUMBER  FELL FORM NUMBER  SEMO WQ LAB. NUMBER  THERI  EMARKSI  F - FLOWING  PLOT THERI  THER	PECIFIC COND. at 25 C 587 C/09/83					
ELL FORM NUMBER  IBMO WQ LAB. NUMBER  YS 2000 NUMBER  THERI  EMARKSI  F - FLOWING  SKETCH MAP  IRPY  IRPY  IRPY  IRPY  IRPY  IRPY  C-3	IBMG FILE NUMBER		<del> </del>	<del> </del>		
SMO WQ LAB. NUMBER  YS 2000 NUMBER  THERI  EMARKSI  F - FLOWING  SKETCH MAP  1/10 Y  1	NR FILE NUMBER					
THERI  EMARKSI  F - FLOWING  TO SERVICE TO THE PROPERTY OF THE	ELL FORM NUMBER			L		
EMARKSI  EMARKSI  F-FLOWING  THERI  ANDREA FIRM  C-3	IBMO WQ LAB. NUMBER	<del></del>	<del></del> -	\ /	BRETCH MAP	
EMARKSI  EMARKSI  F-FLOWING  THERI  ANDREA FIRM  C-3	YS 2000 NUMBER			\ /-	1.4	
F-FLOWING	THERI	/8=				JEN .
F-FLOWING C-3	SEAA DAYS.		Till N	1/1	4	
0-0-11	(EMARKS)		(27)	-x		
0-0-11			(المل	/ /		
0-0-11			_	( )	4,18	100
0-0-11	E - E OWING				1 03'	C-37
DATE TO 100 (0.00)	F = FLOWING 48NG Form 182 (9/79)				0-6-	. 11

COUNTY CASCADE T. 1	_	R	5 Oww	SEC. 18	TRACT DCDC
0 1 # 0 1 LAT N. LONG	" w.	·	JTM	N	ε
TOWN SUBDIVISION				BLOCK	LOT
OWNER'S NAME <u>CENTORUILE</u> SENIOR C	ITIZEN.	s B16. a	ADDRESS _	SAND COUL	ce
	PHONE N	UMBER_		YEAR	
ALT, LAND SURF, AT WELL MSL 3475 M.			LITHOL	ogic Log	
TOTAL DEPTH BELOW LSD 200 M.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD THE	FROM	ТО		DESCRIPTION	
STATIC WATER LEVEL* BELOW LSD ft.	T NOM	.0			
YIELD IN GALLONS PER MIN.					
HOW TESTED TIME (HR.)					<del></del>
IF F, SHUT-IN PRESS. IN PSI					
GEOLOGICAL SOURCE OF HO LINE STONE					
MADISON					
CASING DIA. 6_ In. FROM ft. TO ft.					
in. FROM ft. TO ft.					
CASING TYPE PIRSTIC					
PERFORATED INTERVAL ft. TO ft.					
n. TO n.			-		
ft. TO ft.					
PERFORATION DESC.					
PUMP SIZE (HP.) TYPE					
DATE WELL COMPLETED					· - · · · · ·
			•		
HOW DRILLED					
BY WHOM LIC LIC		<b></b>	<del></del>		
SOURCE OF INFO; WELL APPROP.					
DRILLER OWNER USGS SCS	<del></del>				· · · · · · · · · · · · · · · · · · ·
OTHER: Heal - PRESENT WHEN DRINED	<del></del>		<del>-</del>		
HAS WELL LOCATION BEEN VERIFIED Yes				<del></del>	
HAS WELL LOCATION BEEN VERIFIED	-				
BY WHOM / CRAIS IS MORE AGENCY MB 146					
DATE VERIFIED 6/09/52					
MEAS. POINT ABOVE LSD ft. DATE					
TOTAL DEPTH BELOW LSD ft	<del></del>	<del>  </del>		·	
PUMPING LEVEL BELOW LSD 120 92	<del></del>				
SWL BELOW LSD / 22.92 m. 4/99/22	-	<b></b>			
YIELD IN GPM	<del></del>				
WATER TEMP. C					
SPECIFIC COND. at 25 C 2292 409/82	-		· · · · · · · · · · · · · · · · · · ·		
MBMQ FILE NUMBER					
ONR FILE NUMBER					
WELL FORM NUMBER			<del></del>		
MBMG WQ LAB. NUMBER				SKETCH MAP	
SYS 2000 NUMBER			7. 10 1	. To TRACT	
OTHER:	18	1000	repulle 1	1-(227)	
1		172	"CINE M	<b>N</b>	
REMARKS: 10 NOT USE NTER	بالتلنا	لنا	يادا ك		
1 1 DRINKING FORMY LOTER			ک معالو	, <i>A</i>	
in it is but muit in we				\1	
yer long. (ca)				1)10.5	مان م
*F = FLOWING				JULICNIE	RUIL 8-38
MBMG Form 182 (9/79)					

it, N. LONG	11		UTM N E
T N. LONG	w.		UTM NE
WN SUBDIVISION			BLOCK LOT
NER'S NAME THOMAS BEHRENT			ADDRESS STARRT Seals Coules
	PHONE !	NUMBER	YEAR
T. LAND SURF. AT WELL MISL 2480 ft.			LITHOLOGIC LOG
TAL DEPTH BELOW LSD 107 n.	INTERV	AL (FT.)	
MPING LEVEL BELOW LSO	FROM	то	DESCRIPTION
ATIC WATER LEVEL BELOW LSD ft.	FROM	10	
ELD IN GALLONS PER MIN.	0	10	To12 5011
OW TESTED BAILER TIME (HR.) 2	10	30	BROKEN SANDSTURE & CLAY
	30	3.5	BROKEN SANDSTONE, GRAVE
COLOGICAL SOURCE OF HO LIME STONE			LIATER
MADISW	35	80	GRAY SANDY SIIT
177 51 812 4	80	100	BROWN SANDY SILT
SING DIA 52 In. FROM 0 1. TO 100 1.		107	
	700	1707	Carry Bresterie Historia
in. FROM ft. TO ft.		<del>                                     </del>	
SING TYPE STEEL		-	
REPORTED INTERVAL 31 H. TO 35 H.	- 3	1 2	77
ft. TO ft.	50,3	17:11	
n. 70 1L			
REPORATION DESC. TORCH		<del> </del>	
MP SIZE (HP.) TYPE		ļ	
TE WELL COMPLETED 3/17/78		<u> </u>	
OW ORILLED CARIC		<u> </u>	
WHOM PET RYRNE LIC. 135			
ELL USE Domestic			
URCE OF INFOI WELL APPROP.			
RILLER OWNER USQS SCS			
HER:			
TIEN!		<del> </del>	
S WELL LOCATION BEEN VERIFIED YES			
WHOM HERMAN MOURE AGENCY MEMG		<del> </del>	
ATE VERIFIED			
,			
AS. POINT ABOVE LSD ft. DATE			
TAL DEPTH BELOW LSD ft		<del> </del>	
MPING LEVEL BELOW LSD ft		-	
L. BELOW LSD ft		-	
ELD IN OPM		-	
ATER TEMP. C	-	<b></b>	
ECIFIC COND. at 25°C			
MG FILE NUMBER		ļ	
R FILE NUMBER			
LL FORM NUMBER			
MO WO LAB. NUMBER			SKETCH MAP
S 2000 NUMBER		$\square$	
	10		
HERI	17	7	Well House
****		<del>14</del> /	Theory was
MARKSI		N	C. lee -
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			L
- El Owing		, a. T.	casile, c-39
- FLOWING		1 2010	Cotion in
BMG Form 182 (9/79)			(01.04.54

COUNTY CASCADE T. 19	2 Nove	R. 5	PorW SEC	19 TRA	CT ABAB
LAT N. LONG	11 W.	UTM	N		
N. 2016.	'''	• • • • • • • • • • • • • • • • • • • •			
TOWN SUBDIVISION _			0	_оск	LOT
OWNER'S NAME GOORGE HEAT WAT	11	ADOR	ESS		
	PHONE NUM	85R		YEAR	
ALT. LAND SURF. AT WELL MSL 3575 H.		L	ITHOLOGIC LO	3	
TOTAL DEPTH BELOW LSO 4/0 4.	INTERVAL	(FT.)			
PUMPING LEVEL BELOW LSO TO THE	FROM 1	ro	DESC	RIPTION	
				<del></del>	
YIELD IN GALLONS PER MIN			<del></del>		
HOW TESTED TIME (HR.)	-				-
GEOLOGICAL SOURCE OF H20					
GEOLOGICAL SOURCE OF H20 MANISON					
CASING DIA. 6 In. FROM ft. TO ft.					
ft. TO ft.					
CASING TYPE					
PERFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TO ft.					
PERFORATION DESC.					
PERFORATION DESC.  PUMP SIZE (HP.) TYPE 50 B.					
DATE WELL COMPLETED					
HOW DRILLED					
WELL USE DOMESTIC 4 HOUSES					
WELLUSE DOMESTIC 4 Houses					
SOURCE OF INFO: WELL APPROP.					
DRILLER OWNER _X USGS SCS					
OTHERI					
V.,	-				
HAS WELL LOCATION BEEN VERIFIED YES					
BY WHOM HERMAN MOORE AGENCY MBMG					
DATE VERIFIED 402/82					
MEAS, POINT ABOVE LSO ft. DATE					
TOTAL DEPTH BELOW LSDft					
PUMPING LEVEL BELOW LSD ft					
YIELD IN GPM			<del></del>		
WATER TEMP. C 9.8° (6/02/8)					
SPECIFIC COND. at 25°C /2.84 (/02/82					
MBMG FILE NUMBER					
DNR FILE NUMBER					
WELL FORM NUMBER					
MBMG WQ LAB. NUMBER		1	· TRANSMETCH &	iap.	
SYS 2000 NUMBER		R	(127)		
OTHER:	19	+	da		
			<i>X</i>	4	
REMARKS: WOLL SPRINCE: FOUR HOUSES	لتلتلتك	$R \sim$	() Dont	peaty Line	
AND WATER I' STORED IN A	e Center	.112	Y Production		
4-17-5 wo ast. Holding Mark - Because	Semior	سساهر	1 H	als well	
*F-FLOWING DRILLED AT CENTERVILLE	Services:	Supul -	DT		C-40
MBMG Form 182 (9/79) Genor Citizens Carding	Bu.1011		PATERVY	10.	
JCINO CITIZENICA (OINO			- bateruy		

COUNTY CASCADE T. 15	1 Syors R	1. <u>5</u> (E) or w	SEC. 19 T	RACT CAAD
• ' H N. LONG	w.	UTM	N	
TOWNSUBDIVISION			SLOCK	LOT
OWNER'S NAME RONALD GUISTI			Bay 03 (0)	Un Coulec.
DWNER'S NAME 110NAIA GOISII		ADDRESS Z	90x 7.7.3/*/	op coolee
	PHONE NUMBE	R	YEAR _	
ALT. LANO SURF. AT WELL MIL 3487 tt.		LITHOL	ogic Log	
TOTAL DEPTH BELOW LSD 230 m.	INTERVAL (F	T.)	DESCRIPTION	
	FROM TO		DESCRIPTION	
STATIC WATER LEVEL BELOW LSD ML	0 10	F.11		
VIELD IN GALLONS PER MIN. HOW TESTED VM TIME (HR.) 2	10 16	SAND	y loom	
	16 23		IN SAND S	1.018
IF F, SHUT IN PRESS. IN PSI	23 45	Yells	U SAWD STO	1115
GEOLOGICAL SOURCE OF H20 LIME YONE	45 50		y check and	
7111412010	50 80		I lime Sion	
7%			N horesto	
CASING DIA. (A) In. FROM R. TO R.				
In. FROM ft. TO ft.	175 23	8 hilaHI	CROWN LIE	nc scons
CASING TYPE STEEL		1000		
PERFORATED INTERVAL ft. TO ft.		WATER	AT 125-	238
ft. TO ft.				
ft. TO ft.				
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED ///26/79				
HOW DRILLED CABIC				
BY WHOM PAT BYRNE LIC. 3/8				
WELL USE DOMESTIC				
SOURCE OF INFO! WELL APPROP.				
DRILLER OWNER USGS SCS				
OTHER:				
Vac				
HAS WELL LOCATION BEEN VERIFIED Yes				
BY WHOM HERMAN MODECAGENCY MBMG		-		
DATE VERIFIED 6/20/82				
MEAS. POINT ABOVE LSD ft. DATE				
TOTAL DEPTH BELOW LSD ft				
PUMPING LEVEL BELOW LSO 11. 6/20/82				
SWL* BELOW LSD ft				
YIELD IN OPM 10 4/29/82				
WATER TEMP. C /3.50 (/20/52				
SPECIFIC COND. at 25°C 9/4 6/30/82				
MOMO FILE NUMBER				
ONR FILE NUMBER				
WELL FORM NUMBER			SKETCH MAP	
MBMG WQ LAB. NUMBER		-1		
SYS 2000 NUMBER			CENTERU	110
OTHER		1 -1		
REMARKS, Blown 6 Well		$\bigwedge$		
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	Tame	/_		
	(h.)-	0 Fa27	)	
F - FLOWING	ما	Na wei	(	C-41
MBMG Form 182 (9/79)	C/	<i>y</i> 9	•	
	V	To stocke	T	

COUNTY CASCADE T. 1	2 Des	R.	5 BOW SEC. 19 TRACT CAAL
o I H o I	n W.		UTM N €
TOWN SUBDIVISION _			BLOCK LOT
OWNER'S NAME BRIAN GUISTI			ADDRESS STAR RT STOCKETT
	THOUS I	NI MARC D	YEAR
	THORE	· · · · · · · · · · · · · · · · · · ·	
ALT. LAND SURF. AT WELL MSL 35/0 ft.			LITHOLOGIC LOG
TOTAL DEPTH BELOW LSD 290 ft.  PUMPING LEVEL BELOW LSD 285 ft.	INTERV	/AL (FT.)	
3 2 -	FROM	то	DESCRIPTION
	0	4	BROKEN ROLK
HOW TESTED BALLER TIME (HR.) 2	4	27	GRAY SHAIR
IF F, SHUT-IN PRESS. IN PSI	27	55	HARD SHALE ROCK HOAT 55'
GEOLOGICAL SOURCE OF H20 LIMESTONE	22	6.3	RIACK SAND STONE WARRITE
madion	63	72	GRAY SAND ROLK
	72	75	RUSTY BROWN SANDSTONE
CASING DIA. & In. FROM Q R. TO 7/ H.		25	BROWN SANDSTONE
In. FROM ft. TO ft.	85	180	
CASING TYPE STECT	180		BROWN LIMESTONE 40 ATLE
PERFORATED INTERVAL			
n. TO ft.			
PERFORATION DESC.			
PUMP SIZE (HP.) /2 TYPE			
DATE WELL COMPLETED 8/24/78			
HOW DRILLED CABLE			
BY WHOM PAT BYRNE LIC. 135			
WELL USE DOMPSTIC			
SOURCE OF INFO: WELL APPROP. X			
DRILLER OWNER X USGS SCS			
OTHER:			
HAS WELL LOCATION BEEN VERIFIED			
BY WHOM HERMAN MOORCAGENCY MBMG			
DATE VERIFIED 6/03/82		1	
MEAS, POINT ABOVE LSD -4.50 ft. DATE			
TOTAL DEPTH BELOW LSD ft			
PUMPING LEVEL BELOW LSD ft			
SWL BELOW LSD /96.9 M. /20/52		<u> </u>	
YIELD IN OPM /3.8 6/20/82		ļ	
WATER TEMP. C /2 403/82		<del> </del>	
SPECIFIC COND. at 25°C 826 6/20/82		ļ	
MBMG FILE NUMBER		ļ	
ONR FILE NUMBER			
WELL FORM NUMBER			
MBMG WQ LAB. NUMBER	ملنثما	<del>, , , , , , , , , , , , , , , , , , , </del>	SKETCH MAP
SYS 2000 NUMBER		1 1	Centerville
OTHER:	19-		L. DENIERUME
		<del>    </del>	
REMARKS:	نلحلنا	` لند	الير الروع المراد المرا
			(er. vi
•F • FLOWING		. 1	C-42
MBMG Form 182 (9/79)		CAIL	
		-	1 To STOCKETT

# MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

AT N. LONG	99				_
AT N. LONG	w.		UTM	N	Ε
SUBDIVISION				BLOCK	LOT
NNER'S NAME DIANE KNOX			ADDRESS	Bex 73 S	and Couleer
•	PHONE	NUMBER		YE	AR
T. LAND SURF. AT WELL MIL 3490 ft.			LITHO	LOGIC LOG	
TAL DEPTH BELOW USD 2.58 M.		VAL (FT.)			
MPING LEVEL BELOW LSO	FROM	то		DESCRIPTION	DN
ATIC WATER LEVEL BELOW LSD	-				
LO IN GALLONS PER MIN.		1/6	Jop	Soil	
W TESTED BOWEN TIME (HR.) 2	10	40	SHA	10	
F, SHUT-IN PRESS. IN PSI	40		lime	Rock	
OLOGICAL SOURCE OF HO LIMESTONE					
MAdison					
7/4		-			
SING DIA. PA In. FROM		+			
6/4 In. FROM 20 H. TO 80 H.		-			
SING TYPE STECTO-20-PLASTIC 20-80					
REFORATED INTERVAL ft. TO ft.					
ft. TO ft.					
ft. TO ft.	1				
REPORATION DESC.					
MP SIZE (HP.) TYPE					
TE WELL COMPLETED ///// 79					
WORILLED FLACED ROTARY		1			
WHOM SURE WATER PRIVERS LIC. 178					· · · · -
ILL USE DOMESTIC + STOCK				· · · · · · · · · · · · · · · · · · ·	
URCE OF INFO: WELL APPROP.		1			
ILLER OWNER USQS SCS		<del></del>			
HER:					
V		ļ			
S WELL LOCATION BEEN VERIFIED Yes					
WHOM TERMAN MORE AGENCY MBMG		-	1	<del></del>	
TE VERIFIED 6/02/82		-			
AS. POINT ABOVE LSD ft. DATE					
TAL DEPTH BELOW LSD ft					
APING LEVEL BELOW LSD ft		1			
. BELOW LSO 31.7 M. 6/02/82					
LD IN GPM					
TER TEMP. C /3.2° 6/02/82					
CIFIC COND. et 25°C 29/1 6/02/82					
MG FILE NUMBER					
R FILE NUMBER		†			
LL FORM NUMBER		1			
MG WQ LAB. NUMBER				SKETCH MAP	
3 2000 NUMBER	19	<b>→</b>	\ /	7	
HER:	20		VQ	2)	
		HV		-	
MARKSI NATER 180 GR MARD		۱٬ لند	1		411
			/ MIK		6 millouse
	/ 49	METHE	L /10.	_ L.	PM
		- TODOM	11/	47.	* / C-43
- FLOWING					
MG Form 182 (9/79)			/		
		41	n Stock	eTT	

# MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

COUNTY CASCAD			R.,	4 Porw SEC	. <u>36</u> TR	ACT BAAC
LAT N. L	ong	" w.		UTM	N	ε
TOWN	SUBDIVISION _				BLOCK	_ LOT
OWNER'S NAME ROBER				_		
				736-526		
	_3390 n.					
ALT. LAND SURF. AT WELL MSL		INTERV	AL (FT.)	LITHOLOGIC	LOG	
TOTAL DEPTH BELOW LSD PUMPING LEVEL BELOW LSD	n.			1	ESCRIPTION	
STATIC WATER LEVEL® BELOW LS		FROM	то			
YIELD IN GALLONS PER MIN.	60	.2	-	TOP SO	1	
HOW TESTED BALLER	TIME (HR.)	5	19	Y-1100 C	Fri. ? me	
IF F, SHUT-IN PRESS. IN PSI		14	33	Vensil:	1 /	1:
		3 6	414	DINK CH	ME	
GEOLOGICAL SOURCE OF H20	Leversic Chadyl.	44	50		· / / C ·	
		50	57	1500- 1, 6,	4,1-110	
CASING DIA. 2 In. FROM	_ п. то <u>60</u> п.	-7	75	6000 : 190	1 TUNC	/7, C
	n. TO n.	75	79	1 2 8 2 8 1	1,12	
CASING TYPE		79	92	13 80	SALD STURY	C
PERFORATED INTERVAL		#2	97	11000 BIE	CH SHALE	_
	ft. TO ft.	17	100	000-	HOLE	
	ft. TO ft.			<i>G</i> ′		
PERFORATION DESC.						
PUMP SIZE (HP.) TYPE _						
DATE WELL COMPLETED//-	9-81					
HOW DRILLED PAT BERNE	LIC. 35					
WELLUSE DOMESTIC	,					
WELL USE DOMESTIC	X					
DRILLER OWNER US	sas scs					
OTHER:						
HAS WELL LOCATION BEEN VERIF	FIED YES					
BY WHOM HERMAN MOORE	AGENCY MAMO					
DATE VERIFIED	182					
MEAS. POINT ABOVE LSD	ft. DATE					
	ft					
MINDING LEVEL BELOW LED	•					
SWL+ BELOW LSD 24.	73 n. <u>5/27/8</u> 2					
YIELD IN GPM						
water temp. $^{\circ}$ C $-\frac{9.5}{2}$					,	
SPECIFIC COND. at 25°C /3:	36 5/27/82					
MBMG FILE NUMBER	<del></del>					
DNR FILE NUMBER						
WELL FORM NUMBER						
MBMG WQ LAB. NUMBER			· ·	SKET	СН МАР	
SYS 2000 NUMBER					}	
OTHER:		36				
			N H			=
REMARKS: 010 well /60	o' went		נייו		122	2) HNJON
RAD Due To Fe			Gen	BeR		JOHN IATS
		0 (	7	4444		KO PI
		1	712	5		C-44
F - FLOWING		20	, "F		~ \ \	
MBMG Form 182 (9/79)		10	1,7		1100	BANING TO
		<b>♦</b>			$\mathcal{L}$	Transpoor.

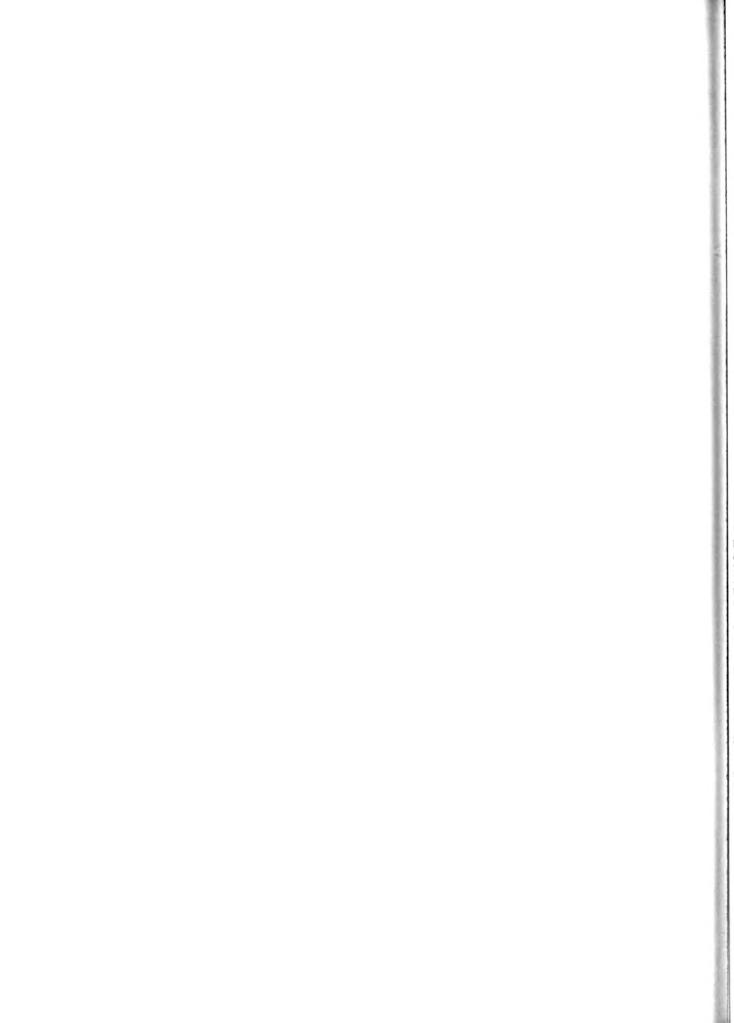
# MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

0 1 H 0 I	w.	UTM	N	Ε
TOWN SUBDIVISION				
OWNER'S NAME SENE GTTO JOHN	SON	ADD	AESS STAP	RT Sund Coulec
	PHONE NU	MBER		YEAR
ALT. LAND SURF. AT WELL MBL 3400 M. TOTAL DEPTH BELOW LSD 25 M.	INTERVAL		LITHOLOGIC LOG	
TOTAL DEPTH BELOW LSD			DESCR	IPTION
STATIC WATER LEVEL BELOW LSD 120 TL		то		
YIELD IN GALLONS PER MIN.				
HOW TESTED TIME (HR.)				
IF F, SHUT-IN PRESS. IN PSI				
GEOLOGICAL SOURCE OF HO LINESIANE				
7/1801201				
( ) ( )				
CASING DIA. 6 In. FROM R. TO R.				
In. FROM ft. TO ft.				
CASING TYPE Tect				
PERFORATED INTERVAL ft. TO ft.	,			
ft. TO ft.	1 1			
ft. TO ft.				
PERFORATION DESC.				
PUMP SIZE (HP.) TYPE				
DATE WELL COMPLETED				
HOW DRILLED				
BY WHOM LIC	-			
BY WHOM LIC WELL USE				
SOURCE OF INFO: WELL APPROP.				
DRILLER OWNER USQS SCS				
OTHER:				
HAS WELL LOCATION BEEN VERIFIED YES				
BY WHOM HERMAN R MOUREAGENCY MBMG				
DATE VERIFIED 5/28/62		ĺ		
MEAS, POINT ABOVE LSD ft. DATE		1		
TOTAL DEPTH BELOW LSD ft		1		
1/01 5/20/12				
EU 3/11/02				
YIELD IN GPM				
WATER TEMP. C 4.0				
SPECIFIC COND. at 25 C	-			
MBMG FILE NUMBER				
DNR FILE NUMBER			-	
WELL FORM NUMBER	1		A. SHETCH MA	,
MBMQ WQ LAB. NUMBER		7 1	TO GENAT FAILS	-1-
SYS 2000 NUMBER		11	(227)	65
OTHER:	31-	ע ב		0 / 1/2
12.11	7 7 7 7 7 7	10	)	lee co-ok
REMARKS	Likekeki	_	:/ /	
			- 1	
			1	C-45
AS - SI OWING			M well,	C-45
•F = FLOWING			11	[(] ) h
MBMG Form 182 (9/79)			/ *	

# MONTANA BUREAU OF MINES AND GEOLOGY WELL-DATA SHEET

COUNTY LAS CADE			R	S & orw s	Ec. <u>51</u>	TRACT DUD
AT N. LON	o 1	w.		UTM	N	Ε
OWN	SUBDIVISION _				_ BLOCK	LO1
OWNER'S NAME Genelo	Traj JoHA	سدوس	well 2	ADDRESS	JAR RT. S	and Coulec
		PHONE N	UMBER_		YEAR_	
ALT. LAND SURF. AT WELL MSL	<u>34/8</u> n. 200 _ n.			LITHOLOG	IC LOG	
TOTAL DEPTH BELOW LSD	200 n.	INTERV	AL (FT.)			
PUMPING LEVEL BELOW LSD	UNUSTD n.	FROM	то		DESCRIPTION	
STATIC WATER LEVEL BELOW LSD						
HELD IN GALLONS PER MIN.						
OW TESTEDT	IME (HR.)					
F F, SHUT-IN PRESS. IN PSI						
DEOLOGICAL SOURCE OF H20	nestone					
	7901501					
CASING DIA. 🕰 In. FROM1		<b>  </b>				
In. FROM (CASING TYPE STECT	n. To n.					
PERFORATED INTERVAL	n. To ft.					
1	n. to n.					
	n. TO ft.					
ERFORATION DESC.						
UMP SIZE (HP.) TYPE						
ATE WELL COMPLETED				ļ		
IOW DRILLED						
3Y WHOM	LIC	ļ				
VELL USE UNUSED						
OURCE OF INFD: WELL APPROP.		ļ				
ORILLER OWNER X USGS	scs					
OTHER:						
	V .					
HAS WELL LOCATION BEEN VERIFIED		-				
BY WHOM HERMAN CIDOREAG						
DATE VERIFIED						
MEAS. POINT ABOVE LSD	ft. DATE			·		
OTAL DEPTH BELOW LSD	ft					
UMPING LEVEL BELOW LSD						
WL* BELOW LSD /2.15	n. 1/28/82					
TELD IN GPM						
VATER TEMP. C						
PECIFIC COND. at 25 C		<b></b>				
BMG FILE NUMBER		<u> </u>				
ONR FILE NUMBER		<b></b>				
VELL FORM NUMBER		L				
IBMG WQ LAB. NUMBER				SHE	ETCH MAP	
YS 2000 NUMBER			1	1		
OTHER:		31		\ _		
	20.5		- N	Q	27)	
REMARKS: LISTER WENT !	-(+1)	لتلقيب	ليت	)		
				}		Johnsons RANK C-46
				/		RANK
F = FLOWING				- X		JOHNSON
MBMG Form 182 (9/79)			,	, Topicy A	n D	C-46
TORISTON 104 (SITE)			10		10.	(weil .

GROUNDWATER QUALITY LABORATORY ANALYSES



- WATER RUALITY ANALYSIS - LAB NO. 8200470

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STATE HONTANA
LATITUDE LONGITUDE 4/R23/01'N 111D08/52'W
                                                                                           COUNTY CASCADE
                                                                               STIE LOCATION 12N SE 12*CAAD 01
                                                                                    MEMG STIF
        UTH CODRIGINATES
        TOPOGRAPHIC HAP COU
GEOLOGIC SOURCE 330
DRAINAGE BASIN 88
                                   COUTREAST GREAT FALLS 7 1
                                                                                                       472301111085201
                                                                               SAMPLE SOURCE
FACE ALTITUME
                                   330MDSN*
                                                                          *
                                                                                                       WELL.
                                                                  LAND SURFACE ALTITUDE SUSTAINED YIELD
                                                                                                       3480. FT 10
10 0 GPH
BUCKET/SIDEWATCH
       AGENCY ( SAMPLER
BOTTLE NUMBER
                                   HEMS*HRM
                                   ROUISII
                                                                         YIÉLD MEAS METHOD
                                                                    TIETH MEAS HE HOH
TOTAL DEPTH OF WELL
ABOVE() OR RELOW GO
CASING PLAMETER
CASING TYPE
COMPLETION TYPE
        BUTTLE ROBBER
DATE SAMPLED
TIME SAMPLED
LAB + ANALYZED
BATE ANALYZED
SAMPLE HANDLING
                                   20 JUN 82
10:45 KOURS
                                                                                                           238. FI (R)
130. FI (R)
                                                                                                           150.
                                                             SHL
                                                                                                       STEEL (H)
                                   HBHG*FNA
                                   16 - JUL - 82
                                                                                                          *
                                                                    PERFORATION INTERVAL
          HETHOR SAMPLED
                                   PUMPED
                  WATER USE
                                  DOMESTIC
        SAMPLING SITE RONALD GUISTL .5 HI SW OF CENTERVILLE GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE
                                                                                                         MG/I.
                                                                                                                      MLQ/L
                                                     HERZI.
                                     MG /!
                                                                                                          222.8
                                                                                                                          3.77
                                                                                         (HC03)
      CALCIUM
                       (CA)
                                     113.
                                                        5.64 BICARBONATE
                                                        3.16 CARBONATE
0.57 CHLORIDE
                                                                                                             2.0
                                                                                          (003)
      MAGNESIUM (MG)
                                       38.4
                                                                                                                          0.00
       SOFILUM
                        (NA)
                                       13.1
                                                                                            (CL)
                                                                                                         312.
                                         4.2
                                                                                          (504)
                                                                                                                          6.50
      POTASSIUM
                                                                SULFATE
                         (K)
                                                        0.11
                                                                                                             $.69
.53
                                         <.002
                                                                                                                          0.41
                                                                NITRATE
                                                                                         (AS N)
       IRON
                        (EE)
                                                                FLUDRUŪE
      MANGANESE
                       (HH)
                                         <.001
                                                                                                                          0,03
                                                                PROSPHATE TOT (AS P)
       SILICA (SIG2)
                                         3.5
                                                                              TOTAL ANIONS
                                                                                                                        10.78
                                                        5.48
          TOTAL CATIONS
          STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                              5,13
                                                                                      (SIGHA)
                                                                                                                   440,22
                                                      14.5 C TOTAL ALKALINITY AS CACO3
611.42 SOBIUM ADSORPTION RATIO
728.02 RYZNAR STABILITY THREY
                                                                       TOTAL HARDNESS AS CASSS
                           LABORATORY PH
                                                                                                                   188.48
          FIELD WATER TEHPERATURE
 CALCULATED DISSOLVED SOLVES
SUM OF DISS. CONSTITUENT
LAB SPEC.COND. (MICROMHOS/CM)
                                                                                                                       6.82
                                                                                                                       0.35
                                                      057.8
                                                                   LANGLIER SATURATION INDEX
                                                                              PARAMETER
                                                                                                                    VALUE
                                                 VALUE
                                                                                                                   714.
                                                                  CNDUCTVY, FIELD HICROPHOS
TEMPERATURE, AIR (C)
                                                 76. F
                                                                  ALKALINITY FLD (AS CACO3)
NICKEL DISS (MG/L AS NI)
                                                                                                                  185.4
                                                 7.53
FIELD PH
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
BORON , DISS (MG/L AS B)
CARMIUM, DISS (MG/L AS CO)
CHROMIUM, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS CU)
                                                                                                                     < . 0.1
                                                   <.003
                                                                  LEAD, DISS (MG/L AS PD)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DIS(MG/L AS TI)
VANDIUM, DISS(MG/L AS V)
                                                                                                                      .05
                                                   <.002
                                                                                                                       .003
                                                   <.02
                                                    .002
                                                                                                                       .007
                                                     .008
                                                                  ZINCIDISS (MG/L AS ZN)
ZIRCONIUM DISCHG/L AS ZR
                                                                                                                       .12
                                                     .013
                                                                                                                       .011
                                                     .014
                                                   <.02
HOLYBDENUH, DISS(HG/L-HO)
REMARKS: WATER CLEAR*TASTE AND SHELL DK*LIGHT DROWN STAIN ON FILTER OWNERS ADDRESS BOX 73 SAND COULSE BLOWING WELL LAB: FU CA 130, HG 44,5 GIVES 10.8 HER CATIONS FOR -,183 SIGHA
EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEQ/L = HILLIGRAMS PER LITER. FT = FEET, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = IOTAL RECOVERABLE. IOT = IOTAL.
                                                     S2
                                                                  0.14
                                                                                AT
                                                                                              OTHER
                                       UM
                                              IJA
                                                           IJ T
OTHER AVAILABLE DATA OTHER FILE NUMBERS:
                                                Y
                                                                              COST:
                   PROJECT:
                                                                                          TO *ROS
                                   29 - JUL - 82
F1730F V2
                                                                                  RY:
       LAST FRIT RATE:
                                                                                          27 HAY 83
PROCESSING PROGRAM:
                                                   (11/3/81)
                                                                         PRINTED:
                                PERCENT HERZU (FOR PIPER PLOT)
```

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8200490

1.1

NA

6.0

CA MG

CL SO4 HC03 0.8 82.8 36.4 003

WATER QUALITY ANALYSIS HONTANA BUREAU OF HINES AND GEOLOGY DUTTE, HONTANA 59701 (406)496-4101 LAE NO. 8200491 STATE LATITUDE-LONGITUDE COUNTY CASCADE HONTANA 47019'09"N 111009'14"N SITE LOCATION 1BN 5E 18\*BBBA N HBMG SITE UTH COORDINATES STATION ID STOCKETT 471905111051401 TOPOGRAPHIC EULOGIC SOURCE DRAINAGE BASIN ENCY SAMPLE SOURCE SPRING SEULOGIC SOUNCE MAINAGE BASIN NOY & SAMPLER DOTTLE NUMBER DATE LAND SURFACE ALTITUDE SUSTAINED YIELD P. P. 3875. FT < 10 ีย∟ผ∗อหลีหั AGENCY SHIRLEY YIELD MEAS KETHOD DATE SAMPLED TIME SAMPLED LAB + ANALYST DATE ANALYZED SAMPLE HANDLING TOTAL DEPTH OF WELL ABOVE(-) OR BELOW OS FLOWING CASING DIAMETER 72-JUN-82 12:15 HOURS SWL HBHG\*FNA CASING TYPE 16-JUL-82 METHOD SAMPLED PERFORATION INTERVAL WATER USE DOMESTIC CAMPLING SITE SHIRLEY, WILLIAH\*2.5 HI UP COTTONWOOD CK GEGLOGIC SOURCE MG/L HEQ/L MG/I. HER/L 32.5 3.10 BICARBONATE 300. 4.72 (HC03) CALCIUM (CA) 3.8 MAGNESIUM (MG) CARBONATE (003) 0.44 CHLORIDE (CL) 10.1 0.11 SOBIUM (NA) 0.57 (K) (SD4) 27.6 0.07 POTASSIUM 2.8 SULFATE 3.002 ≤.001 NITRATE (AS N) 10.1 IRON MANGANESE (HN) FLUORIDE (F) .36 (5102) 9.9 PHOSPHATE TOT (AS P) SILICA TOTAL CATIONS 6.28 TOTAL ANIONS 6.34 STANDARD DEVIATION OF ANION-CATION BALANCE (SIGHA) TOTAL HARDNESS AS CACO3 TOTAL ALKALINITY AS CACO3 LABORATORY PH 7.55 288.83 14.2 C FIELD WATER TEMPERATURE 246.05 SODIUM ADSORPTION RYZNAR STABILITY CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 307.04 457.26 0.26 RATIO INDEX 569.6 LANGLIER SATURATION INDEX LAR SPEC.COND. (MICROHHOS/CH) 0.23VALUE PARABETER VALUE PARAMETER PARAMETER
CNDUCTVY, FIELD HIGROPHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (HG/L AS NI)
LEAD, DISS (HG/L AS FB)
STRONTIUM, DISS (HG/L AS TI)
VANADIUM, DISS (HG/L AS V)
7INC, DISS (HG/L AS ZN)
ZIRCONTUM DISS (HG/L AS ZR) 71 6.75 576. TEMPERATURE, AIR (C) 250. FIELD PH <.01 <.03 ALUHINUH, DISS (MG/L-AL) SILVER, DISS (MG/L AS AG) BORON , DISS (MG/L AS B) CADHIUM, DISS (MG/L AS CD) <.002 <.04 .27 <.02 CADHIUM, DISS(HG/L AS CD) CHROHIUM, DISS (HG/L-CR) ₹.002 .005 <.002 <.001 COPPER-DISS (MG/L AS CU) LITHIUM-DISS(MG/L AS LI) .047 .006 .007 <.003 MOLYRRENUM, RISS (MG/L-MO) 0.02

REMARKS: FROM STOCKETT\* FILTER CLEAR\* WATER CLEAR WILLIAM SHIRLEY\* RT 36 STOCKETT HT, 57480 ARTESIAN SPRING

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, <math>MEQ/L MILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA S2 WI OW PW AT OTHER

OTHER AVAILABLE BATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 29-JUL-82 BY: TP \*BCS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL SO4 HCO3 CO3
49.3 42.5 7.0 1.1 1.7 10.3 87.8 0.0

WATER QUALITY ANALYSIS TAB NO. 8200492

```
MONTANA COUNTY CASCADE 47D23'50'N 110D10'35'N SITE LOCATION 19N 04E 14 DADA
                         STATE
   LATITUDE - LONGITUDE
                                                                                 MRMG SITE
        UTH COORDINATES
                                  SOUTHEAST GREAT FALLS 7 1 217KOTN# #
        TOPOGRAPHIC MAP
                                                                                                   472350110103501
        GEOLOGIC SOURCE 21
DRAINAGE BASIN BR
                                                                                                   WELL
                                                                            SAMPLE SOURCE
                                                               LAND SURFACE ALTITUDE
                                                                                                     3680.
                                                                                                                FI
                                                                                                                       : 0
       AGENCY & SAMPLER DOTTLE NUMBER
                                                                         SUSTAINED YIELD
                                 MRMG*WUR
                                                                      YTELD HEAS HELHOD
                                  SCMU*M2
                                                                 TOTAL REPIH OF WILL ABOVE(-) OR BELOW GS CASING PIAMETER CASING TYPE COMPLETION TYPE PERFORATION INTERVAL
                                 19 JUH 32
14:10 HOURS
                    SAMPLER
                                                                                                      210.
                                                                                                                     (FC)
             DATE
        TIME SAMPLED
LAR - ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                                                                                     150. F
5 IN (R)
                                                                                                                FT (R)
                                                           SUL
                                  HRHG*FNA
                                                                                                  STEFL
                                  07-JUL-82
                                                                                                   01#
          METHOD SAMPLED
WATER USE
                                  PUMPED
                                 PURLIC SUPPLY
        SAMPLING SITE SAND COMMER WIR HISTRY BENCH W ARV SAND COMMERCURE SOURCE SOURCE SOUTHAI FORMATION
                                                  MERZI
                                                                                                     MGZE
                                                                                                                 MERZI.
                                    MG/L
                                                     2.58 RICARBONATE
5.75 CARBONATE
0.75 CHLORIDE
      CALCIUM
                       (CA)
                                     51.7
                                                                                     (HC03)
                                                                                                     444.
                                                                                                                     7.28
                                     69.9
                                                                                                       0.
                                                                                      (003)
      MAGNESIUM (MG)
                                                                                                      ;2.3
71.
       SODIUH
                       (NA)
                                                                                        (CL)
                                                                                                                     0.35
                                                     0.07 SULFATE
      POTASSIUM
                                                                                      (504)
                                                                                                                     1.48
                        (K)
                                                                                                       1.22
                                       .011
                                                     0.00 NITRATE
      IRON
                      (82)
                                                                                     (AS N)
                                                                                                                     0.09
                                        .024
      MANGANESE
                      (HH)
                                                     0.00 FLUORIDE
                                                                                         (F)
                                                                                                        1.1
                                                                                                                     0.06
      SILICA (SIO2)
                                       7.5
                                                              PHOSPHATE TOT (AS P)
                                                                                                                     9.25
          TOTAL CATIONS
                                                      2.15
                                                                           TOTAL ANIONS
                                                   7.69 TOTAL HARDNESS AS CACO3
15. C TOTAL ALKALINITY AS CACO3
453.57 SODIUM ADSORPTION PATTO
678.86 RYTHAR COMPANY
          STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                          0.39
                                                                                                               416.80
                          LABORATORY PH
          FIFLD WATER TEMPERATURE
                                                                                                               364.16
                                                                SOUTUH ADSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION TUBEX
                                                                                                                 0.37
   CALCULATED DISSOLVED SOLIDS
 LAB SPEC.COND. (HICROHHOS/CH)
                                                                                                                  0.46
                                                    789.2
           PARABETER
                                               VAI.UE
                                                                           PARAMETER
                                                                                                              VALUE
                                                               PARAMETER
CNDUCTVY, FIELD MICROMHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, HISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
                                                                                                               833.
TEMPERATURE, AIR (C)
                                               86.
                                               7.48
                                                                                                             738.
FISUR 28.
ALUMINUM, DISS (MG/L-AL)
SILVER,DISS (MG/L AS AG)
DORON,DISS (MG/L AS B)
                                                 < .03
                                                                                                                <.01
                                                                                                                2.04
                                                 <.002
                                                  .05
CARHIUM, DISS(HG/L AS CD)
CHROMIUM, DISS (HG/L-CR)
                                                 <.002
                                                                                                                  .001
                                                 ₹.002
                                                                                                                <.001
COPPER, DISS (HG/L AS CU)
LITHTUH, DISS(HG/L AS LI)
                                                 <.002
                                                               ZÍRCONÍUM DISCHGZL AS ZR
                                                                                                                <.003
                                                  .042
MOLYBRENUK, DISS(MG/L-MO)
                                                  .06
REHARKS: FILTER BROWN SILT * WATER CLOUBY
               JOHN G. MITTAL PRES.
EXPLANATION: MG/L = MILLIGRAMS FER LITER, UG/L = MICROGRAMS FER LITER, MEG/L = MILLIEQUIVELENTS FER LITER. FI = FEET, MT = METERS. (M) = MEASURFR, (F) = ESTIMATER, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.
                                                  52
                                                                      2.11
                                     ดม
                                            WA
                                                         LI 1
                                                               ПU
                                                                            AT
                                                                                         OTHER
OTHER AVAILABLE DATA
OTHER FILE NUMBERS:
                                                                           COST:
                 PROJECT:
LAST EDIT DATE:
PROCESSING PROGRAM:
                                  23 - JUL - 82
                                                                              BY:
                                                                                      TF *CHT
```

S04 HC03 16.2 77.7 28.7 003 ტე გე.მ AK S.S CL 0.3 3.3

F1730F V2

TH CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8200492 NOTE:

(11/3/81)

PERCENT MEQUL (FOR PIPER PLOT)

PRINTEDI

27 - MAY -- 83

#### WATER QUALITY ANALYSIS LAR NO. 8200493

```
STATE HONTANA
LATITUDE LONGITUDE 4702411
                                                                               COUNTY CASCADE
                                                                     SITE LOCATION 19N 4E 13 AADD
                              47024'14"H 110009'17"W
                                                                           HBHG SITE
       UTH COORDINATES
                                    N
                                                                     STATION ID
SAMPLE SOURCE
        OPOGRAPHIC HAP
EOLOGIC SOURCE
DRAINAGE BASIN
                              SOUTHEAST GREAT FALLS 7 1
                                                                                         472414110051701
       TOPOGRAPHIC
                                                                                         WELL
       GEOLOGIC
                               330HDSN*
                                                         LAND SURFACE ALTITUDE
SUSTAINED YIELD
                                                                                           3440.
                                                                                                     FT
                              Y: Y:
                                                                                                         < 10
     DRAINAGE MASUR
AGENCY + SAMPLER
DOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
LAR + ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                                                                              10.0 GEM
                              HBHG*HRM
                                                               YIELD HEAS HETHOD BUCKET/STOPWATCH
                              CHENSTH
                                                          TOTAL DESTH OF WELL
ABOVE(-) OR BELOW GS
CASING DIAMETER
                              รัฐ-มีนี้พี่-ตร
เดเดง ผิงมหร
                                                                                                    FT (R)
FT (R
                                                                                            135.
                                                     SWL
                                                                                             121.
                                                                                                          (R)
                                                                                            5 IN (H)
                              MBMG*FNA
                                                                  CASING TYPE
                              07-301.-82
                                                                                         STEEL
                                                                                            *
        METHOD SAMPLED PUMPED
                                                          PERFORATION INTERVAL
                              DOMESTIC
                WATER USE
          SAMPLING SITE CHARLES ENTSHINGER*TOWN OF NUMBER SEVEN
       GEOLOGIC SOURCE HADISON GROUP OR LIMESTONE
                                MG/L
                                             HERZI.
                                                                                           MG/I.
                                                                                                       HEQ/L
                                                3.77
2.36
0.50
                                 79.6
28.7
                                                                             (HC03)
(CD3)
(CL)
                                                                                           246.9
                                                        BICARBONATE
     CALCIUN
                    (CA)
                                                                                                          4.05
                                                        CARBONATE
                                                                                               . 0
      MAGNESIUM (MG)
                                                                                                         0.11
2.75
0.06
                                                                                              4.0
      SOUTUR
                    (NA)
                                  11.4
                                                        CHLORIDE
                                                                                           132.
                      CKD
                                   2.5
                                                0.06
                                                        SULFATE
                                                                              (504)
      POTASSIUM
                                   ₹.002
₹.001
                                                                                                .71
                                                        NITRATE
                                                                             (AS N)
                    (FE)
      IRON
                                                                                                . 44
                   (HH)
                                                        FLUORIDE
                                                                                                          0.02
      MANGANESE
                                                                                 (F)
                                                        PHOSPHATE TOT
                                                                            (AS P)
                 (3102)
      STLICA
                                                6.85
                                                                                                          7.00
                                                                   TOTAL ANIONS
         TOTAL CATIONS
        STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                0.49
                                                                           (SIRHA)
                                                         TOTAL HARDNESS AS CACO3
                       LABORATORY PH
                                                  7.94
                                                                                                    316.89
                                                13. C
        FIELD WATER TEMPERATURE
                                                                                                    202.50
  CALCULATED DISSOLVED SOLIDS
                                               393.48
518.75
                                                             SODIUM ADSORPTION
RYZNAR STABILITY
                                                                                       RATIO
                                                                                                      0.28
                                                                                                       6.65
 LAB SPECICOND (MICROMHOS/CM)
                                                          LANGLIER SATURATION INDEX
                                                                                                       0.65
                                               596.3
                                                                                                    VALUE
          PARAMETER
                                          VALUE
                                                                   PARAMETER
                                          75. F
7.27
5.03
TEMPERATURE, AIR (C)
                                                         CNDUCTVY, FIELD HICROPHOS
                                                                                                    620.
                                                         ALKALINITY; FLD(AS CACO3)
NICKEL; DISS (MG/L AS NI)
LEAD; DISS (MG/L AS PB)
                                                                                                   412.4
FIELD PH
ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
BORON , DISS (MG/L AS B)
                                                                                                     < .01
< .04
                                                         LEAD, DISS (MG/L AS RE)
STRONTIUH, DISS (MG/L AS PE)
TITANIUH DIS(MG/L AS TI)
VANADIUH, DISS(MG/L AS V)
                                            <.005
                                            <.002
<.002
CADHIUH, DISS(HG/L AS CD)
CHROMIUH, DISS (HG/L-CR)
                                                                                                     <.001
                                                                                                      < .001
COPPER,DISS (MG/L AS CU)
LITHIUH,DISS(MG/L AS LI)
                                                         ZINCĪDISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR
                                             .004
                                                                                                      <.003
                                              .016
HOLYBDENUH, DISS (HG/L-HO)
                                            <.02
```

REMARKS: WATER CLEAR \*TASTE AND SHELL OF SULTY FILTER OWNERS ADDRESS SAND COULEE

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, <math>MEQ/L MILLIEQUIVELENTS PER LITER, FT = FEET, <math>MT = METERS. (M) = MEASURED, (E) = CSTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QU WA S2 WI OW PW AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 23-JUL-82 BY: TP \*CHT
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL S04 HC03 C03
57.6 34.3 7.2 0.9 1.6 39.8 58.6 0.0

# WATER QUALITY ANALYSIS

```
COUNTY CASCADE
                                  ANATHON
                          STATE
   LATITUDE-LONGITUDE 47018/54*N 111011/04*W
                                                                           STIF LOCATION 18N 45 14 ACED
                                                                                  MRMG SITE
STATION ID 471854111110401
        UTH COORDINATES
                                  STOCKETT 7 1/2'
217KOTN#
        TOPOGRAPHIC HAP
        GEOLOGIC SOURCE 213
DRAINAGE RASIN BR
                                                               # SAMÉLÉ SOURCE
LAND SURFACE ALTITUDE
                                                                                                   SPRING
                                                                                                      3880. FI
7.6 GEM
                                                                                                     3880.
      AGENCY & SAMPLER BOTTLE NUMBER
                                                                          SUSTAINED YIELD
                                  HBHG#HRM
        BOTTLE NUMBER R.YUREK
DATE SAMPLED 21 -JUN 82
TIME SAMPLED 10:40 HOURS
LAB + ANALYST MRMG*FNA
DATE ANALYZED 16-JUL-82
SAMPLE HANDLING
METHOD SAMPLED PUMPED
                                                           YIELD HEAS HETHOD BUCKET/STOPWATCH
TOTAL DEFILL OF WELL
SWL ABOVE(-) OR BELOW GS
                                                                          CASING DIAMETER
                                                                          CASING TYPE
                                                                                                        4
                                                                 FERFORATION INTERVAL
                  WATER USE DOMESTIC
        SAMPLING SITE RICK YUREK*.25 HT N OF GIFFEN SPRING GEOLOGIC SOURCE KOOTENAL FORMATION
                                                                                                      MG/1
                                                                                                                   HERVE.
                                                   REQZI
                                    MG/L
                                                      2.45 BICARBONATE
3.20 CARBONATE
0.37 CHIORIDE
                                     49.3
                                                                                      CHC03>
                                                                                                       321.
                                                                                                                      5.26
                       (CA)
      CALCIUN
                                                                                       (003)
                                                                                                          .0
      MAGNESTUH (MG)
                                      38.9
                                                                                        (CL)
                                                                                                         1.5
                                                                                                                      0.05
                                       8.4
      SODIUM
                       (NA)
                                                                                                        24.0
                                                                                                                      0.50
                                                                                        (004)
                      (K)
(FE)
                                       2.4
      POTASSIUM
                                                      0.06 SULFATE
                                        .002
                                                              NITRATE
                                                                                      (AC N)
      IRON
      MANGANESE (HN)
                                                              FLUORIJE
                                                                                          (F)
                                                                                                          .58
                                                                                                                      0.03
                                         .001
      STLICA (SIG2)
                                                              PHOSPHATE TOT (AS E)
                                       8.0
          TOTAL CATIONS
                                                      6.08
                                                                            TOTAL ANTONS
                                                                                                                      6.12
          STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                  (SIGHA)
                                                                                                          0 14
                                                    7.61 TOTAL HARDNESS AS CAROS
10.5 C TOTAL ALKALINITY AS CACOS
255.22 SOUTH ADSORPTION RATIO
458.09 RYZNAR STARTLITY THREE
                                                                                                                283.21
263.27
0.22
7.16
                          LARGRATORY PH
         FIELD WATER TEMPERATURE
 CALCULATED DISSOLVED SOLIDS
SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(HICROMHOS/CM)
                                                                 RYZNAR STABILITY INDEX
                                                                                                                   0.22
                                                     537.4
                                                                                                                VALUE
                                                VALUE
                                                                            PARABETER
           PARAMETER
                                               6,82 F
                                                                CNDUCTYY, FTEED HICROHHOS
ALKALINITY FED (AS CACOS)
NICKEL, DISS (MGZL AS NI)
LEAD, DISS (MGZL AS PD)
                                                                                                                542
TEMPERATURE, AIR (C)
                                                                                                               7,517.
FIELD PH
ALUMINUM, DISS (MG/L-AL)
SILVER, MISS (MG/L AS AG)
DORDN , DISS (MG/L AS D)
CADMIUM, DISS (MG/L AS CD)
                                                 <.03
<.002
                                                                                                                  01
                                                                STRONTIUM, DISS (MG/L - SR)
TITANIUM DIS(MG/L AS TI)
VANADIUM, DISS(MG/L AS V)
                                                 .002
<.002
<.002
.005
                                                                                                                  .30
                                                                                                                 .001
                                                                                                                   .001
CHRONIUM, DISS (HG/L-CR)
                                                                ZINCIDISS (MG/L AS ZN)
ZIRCONIUM DIS(MG/L AS ZR
COPPER, DISS (MG/L AS CU)
LITHIUM, DISS (MG/L AS LI)
                                                                                                                  .066
                                                                                                                   .003
MOLYBDENUM, DISS(MG/L-MO)
                                                   .02
```

REMARKS: WATER CLOUDY WITH RUBBLES\*TASTE & SHELL DE\*LIGHT BROWN : LAIN ON FILTER OWNERS ADDRESS EVANS RT STOCKETT

EXPLANATION: MG/L = MILLIGRAMS PFR LITER, US/L = MICROGRAMS PFE LITER, MEG/L = MILLIEQUIVELENTS PER LITER, FT = FEFT, MT = MELERS. (M) = MFASURFR. (F) = CSTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QU UA S2 UI OU BU AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST: LAST EDIT DATE: 30-JUL-82 RY: TE ★RCS PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL SO4 HC03 C03
40.4 52.3 3.0 1.0 0.8 8.6 70.6 0.0

MONTANA RUREAU OF MINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101 WATER QUALITY ANALYSIS LAB NO. 8200495

```
COUNTY CASCADE
                       STATE HUNTANA
                                                                         SITE LOCATION 19N 4E 23*CCDD
                                47D22'42'N 111D11'30'W
   LATITUDE -- LONGITUDE
                                      N
                                                                               HRMG SITE
       UTH COORDINATES
                                                              MRMG SITE

LS 7 1 STATION ID 472242111113001

* SAMPLE SOURCE WELL

AND SURFACE ALTITUDE 3680. FT < 10

SUSTAINED YIELD 8.6 GPM

YIELD HEAS METHOD BUCKET/STOPWATCH

TOTAL DEPTH OF WELL 100. FT (E)

ABOVE(-) OR BELOW GS

CASING DIAMETER

CASING TYPE
                                SOUTHEAST GREAT FALLS 7 1
       TOPOGRAPHIC MAP
       GEOLOGIC SOURCE
DRAINAGE BASIN
GENCY + SAMPLER
BOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
                                           *
                                                             LAND SURFACE
      AGENCY
                                HENG*UJE
                               LARDCRU
                                          HOURS
                                                        SWI.
       LAR + ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                HBHG*FNA
                                                              CASTNO TYPE
CASING TYPE
COMPLETION TYPE
PERFORATION INTERVAL
                                 18-JUL-82
                                                                                                  *
                               PUMPED
DOMESTIC
         METHOD SAMPLED
                 WATER USE
           SAMPLING SITE LAROCQUE, H*TURNOFF 1.2MI SW OF SAND COULEE
       GEOLOGIC SOURCE
                                                                                                 HG/L
                                                                                                             HEQ/L
                                  MG/L
                                                MEQ/L
                                                                                                 407.
                                                   4,07
                                                          BICARBONATE
                                                                                 (HC03)
                                                                                                                6.67
      CALCIUM
                      (CA)
                                   31.5
                                                    3.92
                                                                                                     . 0
                                    47.7
                                                           CARBONATE
                                                                                   (003)
      MAGNESIUM (MG)
                                                           CHLORIDE
                                                                                                  4.5
65.5
5.72
                                                                                                                0.13
1.36
0.42
                                    14.7
                                                                                    (CL)
                                                   0.54
      SODIUM
                      (NA)
                                     2.9
                                                   0.07
                                                           SULFATE
                                                                                   (SO4)
      POTASSIUM
                       (K)
                                     <.002
                                                           NITRATE
                                                                                 (AS N)
                      (FE)
      IRON
                                                           PHOSPHATE TOT (AS P)
                                                   0.00
                                                           FLUORIDE
                                                                                                      .85
                                                                                                                 0.04
      MANGANESE
                      (HH)
      SILICA
                  ($102)
                                     8.5
                                                   8.71
                                                                        TOTAL ANIONS
                                                                                                                 8.63
         TOTAL CATIONS
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                                    -0.35
                                                                                (SIGHA)
                                                              TOTAL HARDNESS AS CACO3
TOTAL ALKALINITY AS CACO3
                                                                                                           399,84
                                                     7.51
                         LABORATORY PH
  FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                           333.81
                                                  432.68
                                                                  SOMIUH ADSORPTION RATIO
                                                                                                             0.32
 SUM OF DISS. CONSTITUENT
LAB SPEC.COND.(MICROMHOS/CM)
                                                                   RYZNAR STABILITY
                                                                                              INDEX
                                                              LANGLIER SATURATION INDEX
                                                  766.5
                                                                                                             0.44
                                             VALUE
                                                                        PARAMETER
                                                                                                          VALUE
          PARAMETER
                                                                                                         755.
347.
TEMPERATURE, AIR (C)
                                                             CNDUCTVY, FIELD HICROHHOS
                                             63.
                                                             ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
                                             7.39
FISUR PH
ALUMINUM, DISS (MG/L-AL)
SILVER,DISS (MG/L AS AG)
BORDN ,DISS (MG/L AS B)
                                               <.03
                                                                                                            <.01
                                                                              (MG/L AS PR)
                                               ₹.002
                                                             USAD, DISS
                                                                                                            < .04
                                                                                                             .35
                                                .04
                                                             STRONTIUH, DISS (MG/L-SR)
                                              <.002
                                                             TITANIUM BISCHGZL AS TI)
VANADIUM, DISSCHGZL AS V)
ZINC, DISS (MGZL AS ZN)
                                                                                                            <.001
CADMIUM, DISS(MG/L
                           AS CID
CHRONIUM, DISS (NG/L-CR)
COPPER, DISS (NG/L AS CU)
LITHIUM, DISS (NG/L AS LI)
                                                                                                            <.001
                                                             SSIG.ONISS
                                                                                                              .013
                                                             ZÍRCÓNÍÚH DÍSCHÖZÚ
                                                                                                            < .003
                                                .023
                                                                                          AS ZR
```

REMARKS: FILTER CLEAN\*NATER CLEAR HARVEY LAROCQUE\*SAND COULES, MT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEQUIVELENTS PER LITER, FT = FEET, HT = METERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

REALTH TA WE UD IN SS AN ME

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

MOLYBDENUM; DISS(MG/L-MO)

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 DY: TP \*BCS
PROCESSING PROGRAM: F1730P V2 (11/3/81) FRINTED: 27-MAY-83

<.02

PERCENT HER/L (FOR PIPER PLOT) CA HG NA K CL S04 HC03 C03 46,7 45.1 7.3 0.9 1.6 16.7 81.7 0.0

NOTE:

WATER QUALITY AMALYSIS LAB NO. 8200496

```
STATE MONTANA
LATITUDE : LONGITUDE 47823/02*N 111808/52*W
                                                                                                 COUNTY CASCADE
                                     #70214 111008/521W STIF LOCATION 19N SE 199CAAD 01 7 N C HBMG SITE SOUTHEAST GREAT FALLS 7 1 STATION 10 4/2333111085201 330MBSN* * $ SOMBLE SOURCE WILL
         UTH COORDINATES
         TOPOGRAPHIC HAP SOL
GEOLOGIC SOURCE 330
_DRAINAGE BASIN BR
                                                                                                              35 0. FT
                                                                      LAND SURFACE ALTITUDE
                                                                SUSTAINED YIELD 13.8 GEN

SUSTAINED YIELD 13.8 GEN

YIELD MEAS METHOD FUCEST/STOPMATCH

TOTAL DEPTH OF WELL 200. ET (R)

SWL ABOVE(-) OR BELOW GS 196.90 FT (H)

CASING DIAMETER 1. IN
       AGENCY & SAMPLER
BOTTLE NUMBER
                                     MBMG #HRM
                                     BRIANGU
        BOTTE RUMBER BREAMDE

BATE SAMPLED 20 - JUN -

TIME SAMPLED 18:45 -

LAR + ANALYST MBMG*EN

DATE ANALYZED 16-JUL -

SAMPLE HANDLING

METHOD SAMPLED PUMPED
                                      20 - JUN - 82
                                     18:45 HOURS
                                     HBHG≭FNA
16-JIII-82
                                                                                 CASING TYPE
COMPLETION TYPE
                                                                                                              STEEL
                                                                                                                 *
                                                                        PERFORATION INTERVAL
                   WATER USE DOMESTIC
        SAMPLING SITE BRIAN GUISTE .5 HE SW OF CENTERVILLE GEOLOGIC SOURCE HARTSON GROUP OR LIMESTONE
                                                                                                                MG/1
215.7
.0
3.3
                                                                                                                             MERZI
                                       MG/I
                                                        HERZI
                                        37.8
42.4
10.2
                                                                                                                                 3.54
                         (CA)
                                                           4.48 RICARRONATE
                                                                                             (HC03)
       CALCIUM
                                                           3.49 CARBONATE
                                                                                               (0.03)
       MAGNESTUM (MG)
                                                                                                (CL)
(S04)
                                                                                                                                 0.00
                                                                                                               228.
7.55
41
       HUIDOS
                                                           0.44
                                                                    CHLORIDE
                         (NA)
                                                                                                                                 4.75
0.75
0.00
                                           3.6
                                                                    SULFATE
       POTASSIUH
                                                           0.05
                           (K)
                                           ..002
                                                                    NITRATE
                                                                                              (AS N)
       IRON
                         (FE)
       MANGANESE (HN)
                                                                    FLUORIDE
                                                                                                                     . 41
                                                                                                   (F)
                                         12.4
       SILICA (SIO2)
                                                                    PHOSPHATE TOT (AS P)
          TOTAL CATIONS
                                                           8.51
                                                                                   TOTAL ANTONS
                                                                                                                                 8.45
          STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                         (SIGHA)
                                                                                                                   0 63
                            LABORATORY PH
                                                                                                                          358.75
                                                             7.44
                                                                           TOTAL HARDNESS AS CACO3
                                                        12. C TOTAL ALKALINTTY AS CACOS
422.22 SODIUM AUSORPTION RATIO
502.36 RYZNAR STABLLITY INDEX
   FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                                          176.71
                                                                                                                              0.22
                                                                       RYZNAR STABLLITY INDEX
LANGLIER SATURATION INDEX
 SUM OF DISS. CONSTITUENT
LAB SPEC.COND. (MICROMHOS/CM)
                                                                                                                              7.10
                                                                                                                              0.14
                                                         741.6
                                                                     PARAMETER
CNDUCTVY,FIFLD MICROMHOS
ALNALINITY,FIFLD MICROMHOS
ALNALINITY,FIFLD (AS CACO3)
NICKEL,DISS (MG/L AS NI)
LEAD,DISS (MG/L AS PB)
STRONTIUM,DISS (MG/L AS TI)
VANADIUM,DISS(MG/L AS V)
ZINC,DISS (MG/L AS ZR)
ZIRCONIUM DIS(MG/L AS ZR)
                                                                                                                         VALUE
826.
182.8
                                                    VALUE
            PARAMETER
TEMPERATURE, AIR (C)
                                                    82. F
7.00
FIELD PH
ALUMINUM, DISS (MG/L-AL)
STLVER, DISS (MG/L AS AG)
DORON , DISS (MG/L AS E)
CADMIUM, DISS (MG/L AS CD)
                                                                                                                          01
                                                     <.03
<.000
                                                                                                                              . 04
                                                       .05
                                                      <.002
CHROMIUM, DISS (MG/L-CR)
COPPER,DISS (MG/L AS CU)
LITHIUM,DISS(MG/L AS LI)
                                                                                                                             ..001
                                                      <.001
                                                                                                                              .24
                                                      .007
                                                                                                                            4.003
                                                      <.013
MOLYBDENUM, DISS(MG/L-MO)
REMARKS: WATER CLEAR * TASTE % SHELL OK * CLEAN FILTER OWNERS ADDRESS STAR RT STOCKETT
EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEQ/L =
HILLTEQUIVELENTS PER LITER. FT = FFET, HT = HETERS. (H) = HEASURED. (F) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.
ESTIMATED: (R) = REPORTED.
                                                 WA
                                                                                     AT
                                                                                                   DITHER
OTHER AVAILABLE DATA OTHER FILE NUMBERS:
                                                                                   cost:
                   PROJECT:
LAST EDIT DATE:
PROCESSING PROGRAM:
                                     30°JUL 02
F1730° V2 (11/3/81)
                                                                                               TP *RCG
27-MAY-83
                                                                                      RY:
                                                                            PRINTED:
                                 PERCENT MEGAL (FOR PIPER PLOT)
                                                                  CI 804 HC03
J.1 56.7 42.2
                             CA MG
52.7 41.0
                                                 NA
                                                            -\mathbf{K}
                                                                                             0.03
```

HONTANA RUREAU OF MINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101

WATER QUALITY ANALYSIS LAB NO. 8200497

```
STATE MONTANA
LATITUDE-LONGITUDE 47D2410
                                                                                                      COUNTY CASCADE SITE LOCATION 19N 4E 13 ACCB
                                           47124'05"N 111109'51"W
      UTH COORDINATES
                                                                                                               HBHG SITE
      TOPOGRAPHIC MAP
GEOLOGIC SOURCE
DRAINAGE BASIN
                                                                                    ALLS 7 1 STATION ID

* SAMPLE SOURCE

LAND SURFACE ALTITUDE

SUSTAINED YIELD
                                           SOUTHEAST GREAT
                                                                              FALLS 7 1
                                                                                                                                      472405111095101
WELL
      GEOLOGIC
                                           #480M08E
                                                                                                                                      3460. FT < 10
3.2 GPM
BUCKET/STOPWATCH
328. FT (R)
                                           I: F:
   DRAINAGE BASIN RE
AGENCY & SAMPLER MRMG*WJR
DOTTLE NUMBER GKAVULA
DATE SAMPLED 21-JUN-82
TIME SAMPLED 10:40 HOURS
LAR & ANALYST MRMG*FNA
DATE ANALYZED 14-JUL-02
SAMPLE HANDLING
METHOD SAMPLED FUMPED
                                                                             VIELD HEAS HETHOD
TOTAL DEPTH OF WELL
SWL AROVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
CONTROL TYPE
                                                                                                                                                          T (R)
FT (R)
                                                                                                                                           165.
                                                                                                                                               IN
                                                                                                                                      STEEL
                                                                                                                                    ŏ1*
                                                                                      PERFORATION INTERVAL
                    WATER USE DUMESTIC
```

CAMPLING SITE KAVULLA, GEORGE\* SAND COULEE, HT GEOLOGIC SOURCE HARISON GROUP OR LINESTONE

CALCIUM (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE)	MG/I. 111. 44.4 13.6 3.2 .007	3.65 0.59 0.08 0.00	BICARRONATE CARBONATE CHLORIDE SULFATE NITRATE	(HCO3) (CO3) (CL) (SO4) (AS N)	MG/L 284. .0 9.7 236. 1.07	HER/L 4.69 0.27 4.91 0.03
HANGANESE (HN) SILICA (SIO2)	12.3	0.00	FLUORIDE PHOSPHATE TOT	(F) (AS F)	.57	0.03
TOTAL CATIONS		5.87	TOTAL	SHOINA		۶۰98

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA) 0.46

LABORATORY FH	7.15	TOTAL HARDNESS AS CACO	3 459.92
FIELD WATER TEMPERATURE		TOTAL ALKALINITY AS CACO	3 234.57
CALCULATED DISSOLVED SOLIDS	572.74	SODIUM ADSORPTION RATI	0.28
SUK OF DISS. CONSTITUENT	717.85	RYZNAR STABILITY INDE	X 7.02
LAB SPEC.COND.(HICROHHOS/CH)	846.1	LANGLIER SATURATION INDE	X 0.07

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	75 • F	CNDUCTVY, FIELD HICROHHOS	633.
FIELD PH	6.38	ALKALINITY, FLD(AS CACO3)	245.
ALUHINUH, DISS (HG/L-AL)	.03	NICKEL,DISS (HG/L AS NI)	:.01
SILVER•DISS (HG/L AS AG)	<.002	LEAD•DISS (HGZL AS FB)	.06
DORON (DISS (MG/L AS E)	.07	STRONTIUM,DISS (MG/L-SR)	• 66
CADMIUH+DISS(MG/L AS CD)	.005	TITANIUM DIS(MG/L AS TI)	<.001
CHRONIUM, DISS (MGZL-CR)	.004	VANADIUH,DISS(HGZL AS V)	.003
COPPERIDISS (MG/L AS CU)	•010	ZINC:DISS (MG/L AS ZN)	.73
LITHIUH: DISS(MG/L AS LI)	.028	ZIRCONIUH DISCHGZL AS ZR	<.003
MOUYDDENUM,DISS(MG/L-MQ)	<,02		

REHARKS: FILTER LIGHT BEOWN\*WATER CLOUDY GEORGE KAVULLA\*SAND COULSE, HT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEQUIVELENTS PER LITER, FT = FEET, MT = METERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

QU WA SO WE OU PU AT OTHER OTHER AVAILABLE DATA Y OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 RY: TE \*RCS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINJED: 27 MAY-83

CA

NOTE:

42.0 33.2

HG

NA

0.5

IN CORRESPONDENCE: PLEASE REFER TO LAB NUMBER: 8200498

WATER QUALITY ANALYSIS

```
STATE MONTANA COUNTY LATITUDE LONGITUDE 47024/52'N 111009/28'W SITE LOCATION
                                                                               COUNTY CASCADE
                                                                                         19N 4F 12 BABA
                                                                    DOING STIE STATION OF THE LO DAMA MENG STIE STATION IN 472452111692801 SAMPLE SOURCE WILL
       UTH COORDINATES
                               SOUTHEAST GREAT FALLS 7 to
       TOPOGRAPHIC HAP
       GEOLOGIC SOURCE
                              220JRSC#
                                                    *
                                                         LAND SURFACE ALTITUDE
SUSTAINED YIELD
YIELD HEAS METHOD
                                                                                         3430. F) 10
7.8 GPM
FUCKET/STOFWATCH
                     BASIN
      AGENCY & SAMPLER DOTHE NUMBER
                              สมหลับการ
                               EVI. YHAN
       DOTHE NUMBER EVETHAR

DATE SAMPLED 21 - JUN - 82

TIME SAMPLED 09:15 HOURS

LAR F ANALYST MRMG*FNA

DATE ANALYZED 14- JUL - 82

SAMPLE BANDLING
                                                          TOTAL BERTH OF WILL
ABOVE(-) OR BELOW GS
CASTNG DIAMETER
                                                                                          131 - FT (E)
                                                                                                      F1 (E)
                                                     SHI
                                                                                           1 1 1
                                                                                             1 111
                                                                  CASING TYPE
COMPLETION TYPE
                                                                                         STIFL
                                                                                            *
        METHOD SAMPLED
                              PUMPED
                                                          PERFORATION INTERVAL
                WATER USE DOMESTIC
       SAMPLING SITE LYMAN, F*1ST HOUSE ACROSS ROAD FROM TRACY GEOLOGIC SOURCE JURASSIC UNDIFFERENTIATED
                                MG/I
                                             HEQ/I
                                                                                           #671
                                                                                                      MER/1
                                               17.86 BICARRONATE
2.46 CARBONATE
                                                                            (HC03)
     CALCIUM
                    (CA)
                                354.
                                                                                           507.
                                                                                                         8.31
                                115.
27.7
5.5
                                                                                            18.7
     MAGNESIUM (MG)
                                                                             (003)
                                                1.20
                                                                                                        0.53
19.51
0.26
                                                       CHLORIDE
                                                                               (CL)
      SODIUM
                    (NA)
                                                                                           537.
                                                0.14
                                                        SULFATE
                                                                              (S04)
      POTASSIUM
                      (K)
                                                      MITRATE
                                                                                              3.67
                    (FE)
                                                0.00
                                                                             (AS N)
      IRON
                                                                                               . 18
      MANGANESE
                                    .004
                                                0.00 FLUORIDE
                                                                                 (F)
                                                                                                         0.01
                    (88)
      SILICA (SIO2)
                                                        PHOSPHATE TOT (AS P)
                                  25.3
        TOTAL CATIONS
                                               28.47
                                                                   TOTAL ANIONS
                                                                                                        28.62
        STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                               0.22
                                                                         (SIGHA)
                                                           TOTAL HARDNESS AS CACOS
TOTAL ALKALINITY AS CACOS
                                                                                                  1357.28
                       LABORATORY PH
                                                 7.54
  FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS
                                                                                                    415.83
                                             1737.03
                                                             SODIUM AUSORPTION RATIO
                                                                                                      0.33
       SUM OF DISS. CONSTITUENT
                                             1774.28
                                                          RYZNAR STABLLITY INDEX
LANGLIER CATURATION INDEX
 LAB SPEC.COND. (MICROMHOS/CH)
                                             2172.
          PARAMETER
                                          VALUE
                                                                   PARAMETER
                                                                                                   VALUE
                                                         CHDUCTVY, FIFID AICROMHOS
ALKALINITY, FIR (AS CACOS)
NICKEL, DISS (MGZI AS NI)
                                          72. F
7.15
.26
                                                                                                  2240.
TEMPERATURE, AIR (C)
                                                                                                  326.
CIELD PH
                                                                                                      .03
ALUMINUM, DISS (MG/L-AL)
                                                         ESAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DISCMG/L AS TI)
VANADIUM, DISS (MG/L AS V)
SILVER, DISS (HG/L AS AG)
BORON , DISS (HG/L AS E)
CADHIUM, DISS (HG/L AS CD)
                                             ,049
,07
                                                                                                     1.08
                                             .015
                                                                                                      .030
CHROMIUM, DISS (MGZI-CR)
COPPER,DISS (MGZL AS CU)
LITHIUM,DISS(MGZL AS LI)
                                             .031
                                                                                                      .048
                                                         ZINCIDISS (HG/L AS ZN)
ZIRCONIUM DES(HG/L AS ZR
                                             .074
                                                                                                      .005
                                             .057
                                                                                                       .056
MOLYBRENUM, DISS(MG/L-HO)
                                              .03
REHARKS: FILTER CLEAN*WATER CLEAR
             EVELYN LYMAN*SAND COULEE, MT
EXPLANATION: MG/L = MULLIGRAMS PER LITER, UG/L = MUCROGRAMS PER LITER, MER/L =
MILLIEQUIVELENTS PER LITER: FT = PEFT, HT = HETERS. (H) = HEASURED. (F) =
ESTIMATED, (R) = REPORTED.
                                         TR = TOTAL RECOVERABLE.
                                                                             TOT = TOTAL .
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OTHER AVAILABLE BATA
OTHER FILE NUMBERS:
                                                                   COST:
                PROJECT:
                                                                             TP #TP
"7 MAY 83
                            05-JAN-83
F1730F V2 (11/3/81)
                                                                      RY:
     LASI CRIT DATE:
                                                               PRINTED:
PROCESSING PROGRAM:
                           PERCENT MEGAL (FOR PIPER PLOT)
```

Ci

S04 HC03

1.7 68.8 22.3

-603

 $\sqrt{-55}$ 

HONTANA BUREAU OF MINES AND GEOLOGY BUTTE, HONTANA 59701 (406)496-4101 WATER QUALITY ANALYSIS LAB NO. 8200455 STATE MONTANA COUNTY CASCADE SITE LOCATION 19N 5E 10\*CEDD LATITUDE -LONGITUDE 47D23'46"N 111D09'09"W UTH COORDINATES SOUTHEAST GREAT FALLS 7 1 330MDSN# # # TOPOGRAPHIC STATION MAF 472346111090901 ID GEOLOGIC SOURCE DRAINAGE BASIN AGENCY + SAMPLER BOTTLE NUMBER 330HDSN\* \* SAMPLE SOURCE WELL LAND SURFACE ALTITUDE 3455. F: J: FT < 10 II.2 Grm SUSTAINED YIELD MRHG\*HRM BUCKÉT/STOPWATCH NET YIELD HEAS HETHOD TOTAL DEETH OF WELL SWL ABOVE(-) OR BELOW GS CASING DIAMETER DATE SAMPLED TIME SAMPLED 175. FT (R) 79.76 FT (H) HOURS LAR } ANALYST DATE ANALYZED SAMPLE HANDLING 8 IN (h) HRMG\*FNA

SAMPLING SITE TERRY NET\*.75 HI NW OF CENTERVILLE GEOLOGIC SOURCE HADISON GROUP OR LIMESTONE

STANDARD DEVIATION OF ANION-CATION BALANCE

DOMESTIC AND STOCK

16-300 82

PUBPED

METHOD SAMPLED

WATER USE

MG / I	KED/L			HG / I	HER/L
		BICARBONATE	(HCG3)		4.45
23.6			(003)	.0	
フ・t	0.31	CHLORIDE	(CL)	3.1	0.09
3.1	0.08	SULFATE	(SO4)	65.7	1.37
.018	0.00	NITRATE	(AS N)	5.69	0.41
.002	0.00	FLUORIDE	(F)	.50	0.03
15.7		PROSPHATE TOT	(AS P)		
	5.60	TOTAL	SHOINA		6.33
	7.t 3.1 .018 .002	65.5 3.27 23.6 1.94 7.1 0.31 3.1 0.08 .018 0.00 .002 0.00	65.5 3.27 BICARBONATE 23.6 1.94 CARBONATE 7.1 0.31 CHLORIDE 3.1 0.08 SULFATE .018 0.00 NITRATE .002 0.00 FLUORIDE 15.7 PHOSPHATE TOT	65.5 3.27 BICARBONATE (HCO3) 23.6 1.94 CARBONATE (CO3) 7.1 0.31 CHLORIDE (CL) 3.1 0.08 SULFATE (SO4) .018 0.00 NITRATE (AS N) .002 0.00 FLUORIDE (F) 15.7 PHOSPHATE TOT (AS P)	65.5 3.27 BICARBONATE (HCG3) 271.3 23.6 1.94 CARBONATE (CG3) .0 7.1 0.31 CHLGRIDE (CL) 3.1 3.1 0.08 SULFATE (SG4) 65.7 .018 0.00 NITRATE (AS N) 5.69 .002 0.00 FLUGRIDE (F) .50 15.7 PHGSPHATE TOT (AS P)

CASING TYPE COMPLETION TYPE

(SIGHA)

PERFORATION INTERVAL

STEEL

3.31

LABDRATORY PH TOTAL HARDNESS AS CACO3 260.69 7.68 12,5 C TOTAL ALKALINITY AS CACO3
323.66 SOBIUM ADSORPTION RATIO
461.31 RYZNAR STABILITY INDEX
580.7 LANGLIER SATURATION INDEX 200.51 0.19 6.99 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT SPEC.COND. (HTCROHHOS/CH) 0.34

PARAMETER	VALUE	PARAME FER	VAI, UE
TEHPERATURE, AIR (C)	85. F	CNDUCTVY,FIELD HICROHHOS	597.
FIELD PH	7.12	ALKALINITY,FLD(AS CACO3)	232.
ALUMINUM, DISS (HG/L-AL)	.04	NICKEL,DISS (HG/L AS NI)	.02
SILVER+DISS (HG/L AS AD)	.024	LEAD, DISS (MG/L AS PB)	.05
DORON FRISS (MG/L AS D)	<.02	STRONTIUM,DISS (MG/L-SR)	.34
CADMIUM,DISS(MG/L AS CD)	,007	TITANIUH DIS(HG/L AS TI)	<.001
CHROHIUH, DISS (HG/L-CR)	.015	VANADIUH,DISS(HG/L AS U)	.015
COPPER:DISS (HG/L AS CU)	•028	ZINC:DISS (MG/L AS ZN)	.16
LITHIUH, DISS(HG/L AS LI)	+025	ZIRCONIUM DIS(HGZL AS ZR	,024
MOLYBRENUH+DISS(HG/L-MO)	.02		

REMARKS: WATER CLEAR\*SHELL AND TASTE OK\*SOLID BROWN SPOTS ON FILTER SILT CUNERS ADDRESS BOX 25 STAR RT STOCKETT LAB: FU CA 76.6, MG 27.9 GIVES 6.51 MEQ CATIONS FOR -.84 SIGMA

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIERUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

GM 82 WI fILL Fill OTHER NA AT

OTHER AVAILABLE BATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: 30-JUL-82 TP \*ROS BY: PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27- HAY-83

> PERCENT HEQ/L (FOR PIPER PLOT) K CI SO4 HCO3 1.5 23.2 75.3 CA HG NA 0.03 58.4 34.7 1.4

WATER RUALITY AMALYSIS TAB ND. REPROSOO

STATE HUNTANA COUNTY CASCADE LATITUDE - LONGITUDE 47024'48'N 111009'46'W SITE LOCATION ISN: 45 12 DRAA UTH COORDINATES DILC OHRH SOUTHEAST GREAT FALLS 7 1 TOPOGRAPHIC HAP STALTON 11 422448111094601 GEOLOGIC SOURCE DRAINAGE BASIN \* SAMPLE SOURCE U. LL LAND SURFACE ALTITUDE 3440 330HDSN# \* 3440. BASIN F: 3: F T 10 DRAINAGE BASIN BE
AGENCY + SAMPLER MRHG\*UJB
DOTILE NUMBER KAJALA
DATE SAMPLED 20 JUN 82
TIME SAMPLED 15:15 HOURS
LAB + ANALYSI MRMG\*ENA
DATE ANALYZED 14-JUL-82
SAMPLE HANDLING SUSTATHER YIELD Gfra YIELD MEAS HETHOD HUCKLISTOPHATCH
TOTAL BECTH OF WELL 158. (1 (k)
ABOVE(-) OR BELON GS 101.34 FT (h)
CASING DIAMETER 4.5 IN (K)
CASING TYPE STEEL
COURTERION TYPE 01\* SWL METHOD SAMPLED PERFORATION INTERVAL PUMPED WATER USE DOMESTIC SAMPLING SITE FAST ACROSS HIWAY TRACY\*3RD HOUSE ON RIGHT GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE mG/4 233.7 MGZI MED/I nt G / I 75.8 26.5 CALCIUM (CA) 3.78 BICARRONALE (HC03)3.83 ((03) MAGNESIUM (MG) 2.18 CARBONATE 2.2 0.51 0.26 2.77 0.03 11.8 SOLIUM CHLORIDE (HA) (CL)(នំពិង) (AS)អូវ) POTASSIUM (K) 2.5 SULFATE 1.33. 0.06 0.002 TRON (FE) NITRATE .118 MANGANESE (HN) .005 FLUORIDE . 5.4 0.00 (F) 0.03 SILICA (SIG2) PHOSPHATE TOT (AS F) 11.8 6.95 TOTAL CATIONS 6.54 TOTAL ANTONS STANDARD DEVIATION OF ANION-CATION RALANCE 2,01 (SIGHA) TOTAL HARDNESS AS CACO3 TOTAL ALKALINITY AS CACO3 LABORATORY FH 7.58 298.35 FIELD WATER TEMPERATURE 171.67 CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND.(MICROMHOS/CM) SOBTUH ABSORFITON RATIO RYZNAR STABILITY INDEX LANGLIER SATURATION INDEX 382.15 0.30 505.73 617.2 7.10 CARAMETER VALUE PARAMETER UAL BE TEMPERATURE, AIR (C) 85. F 7.35 CNDUCTVY FIELD MICEOMHOS 640. ALKALINITY FID (AS CACO3) TELD OH 200. ALUMINUM, DISS (MG/L-AL)
SILVER,DISS (MG/L AS AG)
DORON ,DISS (MG/L AS E)
CADMIUM,DISS(MG/L AS CD) • 0B NICKEL DISS (MG/L AS NI) RICKELFULSS (MOZE AS RE)
LEAR-DISS (MGZE AS PE)
SIRONITUM-DISS (MGZE AS TE)
LUTANTUM DISS(MGZE AS TE)
VANADIUM-DISS(MGZE AS TE)
ZIRCONIUM DISS(MGZE AS ZR)
ZIRCONIUM DISS(MGZE AS ZR) .014 . 64 . 23 .006 .004 CHRONIUM, DISS (HGZL-CR) COPPER,DISS (HGZL AS CU) LITHIUM,DISS(HGZL AS LI) 016 .010 020 . 15 MOLYRDEHUM, DISS(MG/L-MO) .02 REMARKS: FILTER RUSTY BROWN\*WATER CLOUDY RICHARD KUJALA\*BOX 53\*SAND COULEE FU CA 80.4, HG 28.4, NA 12.7 GIVES 6.96 HER CATIONS FOR .07 SIGNA EXPLANATION: HGZL = HILLIGRAMS PER LITER, UGZL = HICKOGRAMS PER LITER, HEGZL MILLIEQUIVELENTS PER LITER. FT = FEFT, HT = MFTERS. (M) = MEASURED, (E) = CSIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL. CSTIMATED, (R) = REPORTED. NA S2 กม FILE AT DIMER OTHER AVAILABLE DATA OTHER FILE NUMBERS: Υ

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 RY: TE \*RCS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27 MAY 83

MONTANA BUREAU OF MINES AND GEOLOGY DUTTE, HONTANA 59701 (406)496-4101

#### WATER QUALITY ANALYSIS LAB NO. 8200501

```
STATE
                               ANATHOM
                                                                                   COUNTY CASCADE
                                477126/22 N 111710/29 W
                                                                       SITE LOCATION
   LATITUDE - I. ONGITÜDE
                                                                                             20N SE 31*CDAA
       UTH COORDINATES
TOPOGRAPHIC MAP
GEOLOGIC SOURCE
DRAINAGE BASIN
                                                           NLIS 7 1 STATION ID

* SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
                                ŠOUTĤEAST GREĀT FALLS 7 1
                                                                                              472622111102901
                                330HDSN*
                                                                                              U). LL
                                                                                               3400.
                                F: F:
                                                                                                         FI
                                                                                                                  10
      AGENCY F SAMPLER
BOTTLE NUMBER
                                                                                                   5 , 1 66 h
                                HRMG*HRM
                                                       SUSTAINSU TIELD
YIELD HEAS HETHOD
TOTAL DEPTH OF WELL
SWL AROVE(-) OR RELOW GS
CASING DIAHETER
CASING TYPE
COMPLETION TYPE
                                                                                             BUCKET/STOPWATCH
125. FT (R)
65.45 FT (H)
                                HORMHOL
            DATE SAMPLED
                                18-JUN-82
                               14:05 HOURS
       LAR + ANALYST
BATE ANALYZED
SAMPLE HANDLING
                                HRMG*FNA
                                                                                                   (H) HI
                                16-JUL-82
                                                                                              STEEL
                                                                                                *
         METHOD SAMPLED
                               PURPED
                                                             PERFORATION INTERVAL
                               DOMESTIC AND STOCK
                WATER USE
       SAMPLING SITE GENE JOHNSON RANCH 1.75 HI NE OF TRACY GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE
                                               HERZI.
                                                                                               KG/L
                                                                                                           HEQ/L
                                 MG/I.
                                                  7.27 DICARBONATE
                                  146.
                                                                                (HC03)
                                                                                               421.
      CALCIUM
                     (CA)
                                                                                                              6.90
                                 83.3
107.
3.3
                                                  6.85
                                                                                                   .0
      MAGNESTUM (MG)
                                                         CARBONATE
                                                                                 (003)
                                                                                                 13.9
                                                                                                             0.39
11.74
0.21
      SODIUM
                     (HA)
                                                  4.65
                                                          CHUBRIDE
                                                                                   (CL)
      POTASSIUM
                                                  0.08
                                                          SULFATE
                                                                                  (S04)
                                                                                               564.
                       (K)
                                     .002
                                                                                                  2.96
                     (FE)
                                                         NITRATE
                                                  0,00
                                                                                (AS N)
      IRON
      MANGANESE
                                      .002
                                                                                    (F)
                                                  0.00 FLUORIDE
                    (HN)
                                                                                                    .37
                                                                                                               0.02
      SILICA
                  (SI02)
                                   17.3
                                                          PROSPHATE TOT (AS P)
         TOTAL CATIONS
                                                 18.88
                                                                      TOTAL ANIONS
                                                                                                             19.27
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                              (SIGHA)
                                                                                                    1,01
                        LABORATORY PH
                                                    7.47
                                                                TOTAL HARDNESS AS CACO3
                                                                                                        707.42
                                               9.0 C TOTAL ALKALINITY AS CACO3
1147.52 SODIUM ADSORPTION RATIO
1361.13 RYZNAR STABILITY INDEX
  CALCULATED DISSOLVED SOLIDS
                                                                                                        345.29
1.75
6.12
0.67
       SUH OF DISS. CONSTITUENT
 LAB SPEC.COND. (MICROHNOS/CH)
                                               1585.
                                                             LANGLIER SATURATION INDEX
          PARAMETER
                                            VALUE
                                                                      PARABETER
                                                                                                        VALUE
                                                           CNDUCTVY, FIELD HICROMHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
                                            77.
                                                                                                       1698.
TEMPERATURE, AIR (C)
                                                                                                       324.
FISUD PH
ALUMINUM, DISS (MG/L-AL)
                                              .06
                                                                                                         < 01
SILVER, DISS (HG/L AS AG)
BORON , DISS (HG/L AS E)
CADHIUH, DISS (HG/L AS CD)
                                                           LEAD, DISS (MG/L AS PR)
STRONTIUM, DISS (MG/L-SR)
                                               ,011
                                                                                                           .03
                                                                                                          1.01
                                                            TITANIUM DIS(HGZL AS TI)
                                               .002
                                                                                                          .002
CHROMIUM, DISS (HGZL-CR)
COPPER, DISS (HGZL AS CU)
LITHTUM, DISS (HGZL AS LI)
                                                           VÂNADÎUM, DÎSS(HG/L AS V)
ZINC, DISS (HG/L AS ZN)
ZIRCONTUM DIS(HG/L AS ZR
                                               .008
                                                                                                           .011
                                               .021
                                                                                                           .013
                                               .067
                                                                                                           .018
```

REMARKS: WATER CLEAR\*TASTE AND SHELL OK\*FILTER CLEAN OWNERS ADDRESS STAR RT SAND COULEE

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L MILLIEQUIVELENTS PER LITER. FT = FEEL, MT = METERS. (M) = MEASURED, (F) = ESTUMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

HOLYBDENUH . DISS (HG/L-HO)

cost: PROJECT: LAST FULL DATE: PROCESSING PROGRAM: 05-JAH-83 BY; TF \*TF 27-HAY-83 F1730F V2 (tt/3/8t) PRINTED:

> DERCENT HEQZL (FOR PIPER PLOT) CL 504 HC03 3.1 61.7 36.2 CA MG NA - K 0.03 38.6 36 3 24.7 0.4 0.0

STATE MONTANA COURT CA ADD LATITUDE CONGITUDE 42018/15'N 111011/05'N STIF LOCATION 100 /1 3 AFER UTH COORDINATES STATION IN ACCURATE CONTRACT 7 N SIDCRETT 7 1/ 220JKSC# TOPOGRAPHIC HAP SIG GEOLOGIC SOURCE 220 DRAINAGE BASIN BE STATION OF A COLOR OF A COLOR OF A CAMPUS SHURE SHURE 3010, 11 COMPANY OF A CAMPUS AND A CAMPUS GEOLOGIC DRACKAGE BASEN BE
AGENCY + SAMPLER MBHG\*HRH
BOTTLE NUMBER RSINGLE
DATE SAMPLED 21 JUN 82
TIME SAMPLED 14:39 HOURS
LAB + ANALYSI MRMG\*ENA
DATE ANALYZED 16 JUL 82
SAMPLE BANDLING
HETHOR SAMPLED BUMBER SHUTATHER TITLE STORMATOR

YIFUE MEAS HERROR RUCKEL/STORMATOR

FOTAL REPTH OF WELL SS. OF LEE

SWI ABOVE ( ) OR RELOW OS SE. FI CE
CASUMG RUARTICK ( IN CE)

CASUMG REPTH FLACING

COMPLETION TYPE # METHOD SAMPLED FUMPED PERFORATION INTERVAL WATER USE SAMPLING SITE RALPH SINGLE 3.25 MI SW OF STOCKETT GEOLOGIC SOURCE JURASSIC UNDITTERRENTIATED 373.3 MEG 1 MG / L HE P/I 57.3 2.84 BICARRONATE 2.17 CARBONATE 0.32 CHLORIDE CALCIUM (CA) CHC030 4.43 26.4 34.2 MAGNESTUM (MG) (E03) SOFIUM (NA) (01) 0.07 (t) POTASSIUM 0.08 SULFATE (504) 0.71 .002 HITRATE IRON (FE) CAS No 4.18 0.30 . 70 MANGANESE (MN) 002 (F) 0.00 HUURTIE 0.05 STITCA (SIO2) PHOSEBATE TOT (AS 8) 5.3 5.60 TOTAL CATIONS 5.43 TOTAL ANTHUS STANDARD DEVIATION OF ANION CATION RALANCE (SIGHA) 9.7 7.20 IOTAL HARDNESS AS LACO3
9.2 C TOTAL ALNALINTLY AS CACO3
277.20 SOBIUM ADSORPTION RATIO
415.87 RYTNAR STABLLITY INDEX
509.4 LANGLIER SATURATION UNDEX 251.24 LABORATORY PH 724.15 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLTES SUM OF BISS. CONSTITUENT LAB SPEC.COND. (MICROMHOS/CM) -0.19 PARAMETER VALUE PARAMETER MALUE B1. F CNDUCTVY, FTFLD HICROHHOS 6.45 ALAALINITY, FLD (AS GACG3) TEMPERATURE, AIR (C) 528. 30. DISUD PHO ALUMINUM, DISS (MG/L-AL) SILVER,DISS (MG/L AS AG) DORON, DISS (MG/L AS B) <.03 NICKEL + RISS (MG/L AS NI) <.002 LEADINISS (MG/L AS PR) STRONTIUMINISS (MG/L-SE) . 1 <.02 .18 CADMIUM, DIESS (MG/E AS CD) ..002 TITANTUM RTS(HGZL AS TI) VANADTUM, DISS(HGZL AS C) ZINC, DISS (HGZL AS ZN) .002 .001 CHROMIUM, ICISS (MG/L-CR) COPPER-DISS (MG/L AS CU) LITHTUM-DTSS(MG/L AS LI) .0.0 .037 ZIRCONTUM JUS (MGZI AS ZE .007 .004 HOLYBUENUM, DISS(HG/L-HO) 4.02 REMARKS: WATER CLEAR\*TASTE % SHELL OK\*CLEAN FILTER
OWNERS APPRESS STAR RT STOCKETT
LAB: FU CA 59.3, MG 27.7 GIVES 5.64 HER CATIONS FOR ... C. STOHA EXPLANATION: MG/L = MILLIGRANS PER LITER. UG/L = MICROSRANS PER LITER. MEG/L

HILLIFRUIVELENTS PER LITER. FT = FFF1, MI = MLIFRS. (M) = MLASHRED. (F) = CSTIMATED. (R) = REPORTED. IR = TOTAL RECOVERABLE. IGT = IGTAL.

ΩW. NA S2 WIULL PW A1 GIBER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT:

COST: 05-JAN 83 F1730F V2 (11/3/81) 18 \* 11 27 MAY 83 LAST EDIT DATE: FIY . PROCESSING PROGRAM: PRINTED:

> PERCENT MED/U (FOR PIPER PLOT) N EL S04 HC03 0 1.4 13.5 85.1 CA НG NA 0.03 52.6 40.0 ().() 5.8 1.6

MONTANA BURCAU OF MINES AND GEOLOGY BUILE, MONTANA 59701 (406)496 4101

WATER QUALITY ANALYSIS LAB NO. 0200503

```
STATE
                                MONTANA
                                                                                     COUNTY CASCADE
                                 47019759*N 111D10741*R
   LATITUDE -LONGITUDE
                                                                          SITE LOCATION 18N AF 11 AAAC
                                                             HRHG SITC
STATION ID
* SAMPLE SOURCE
LAND SURFACE ALTITUDE
SUSTAINED YIELD
                                 STOCKETT 7 1/2/
        UTH COORDINATES
        TOPOGRAPHIC MAP
                                                                                                 421959111104101
         COLOGIC SOURCE
DRAINAGE BASIN
                                                                                               ₩£££
4070.
                                 217KOTN*221HRSN*
        GCOLOGIC
                                                        SUSTAINED YIELD 7.2 GPH
YIELD HEAS HETHOD BUCKET/STOPWATCH
TOTAL DEPTH OF WELL 131, FT (R)
SWL ABOVE(-) OR BELOW GS 17,70 FT (H)
CASING DIAMETER 6 IN (H)
CASING TYPE STEEL
COMPLETION TYPE 03*
PERFORATION INTERVAL
                                 F: 3:
      AGENCY + SAMPLER
BOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED
                                 HRHG*HRM
                                 D.YUREK
                                 21-JUN-82
16:00 HOURS
       LAR F ANALYST
DATE ANALYZED
SAMPLE HANDLING
                                 HRMG*ENA
                                 16-JUL-82
         HETHOD SAMPLED PUMPED
                                 DOMESTIC AND STOCK
                 WATER USE
       SAMPLING SITE DONALD YUREK RANCH 1.75 HI SW OF STOCKETT GEOLOGIC SOURCE KOOTENAL FORMATION
                                   MBZI.
                                                 RED / I
                                                                                                  KG/I
                                                                                                               MER/L
                                                    3.38 BICARBONATE
                                    37.8
                                                                                                  371.2
                      (CA)
                                                                                                                  6.10
      CALCIUM
                                                                                  (HC03)
                                    36.4
                                                                                                     7.8
8.8
                                                                                    (603)
      MAGNESTUR (HG)
                                                    0.92
      SOUTH
                                                            CHEORIDE
                                                                                      (CL)
                                                                                                                  0.00
                      (NA)
                                                            SULFATE
HITRATE
                                                    0.17
                                                                                    (SD4)
                                                                                                    36.8
                                                                                                                  0.77
      POTASSIUM
                        (4)
                                      0.002
                      (ÈÈ)
                                                                                                     5.47
                                                                                   CAS AD
      ていいり
                                                                                                       .97
      MANGANESE (MN)
                                                    0.00 FLUORIDE
                                                                                       (F)
                                                                                                                  0.05
                                       .050
      STLICA
                 (SIO2)
                                                            PHOSPHATE TOT (AS P)
                                                                         TOTAL ANIONS
         TOTAL CATIONS
                                                    7.47
                                                                                                                  7.38
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                 (SIGHA)
                                                                                                     ·· 0 , 41
                                                    7.37 TOTAL HARDNESS AS CACO3
12.1 C TOTAL ALKALINITY AS CACO3
                         LABORATORY PH
                                                                                                            319.12
  CALCULATED DISSOLVED SOLIDS
                                                                                                            305.02
                                                  368.69
557.39
657.1
                                                                  SODIUM ADSORPTION RATIO
                                                                                                               0.52
                                                                    RYZNAR STABLLITY
       SUM OF DISS. CONSTITUENT
                                                                                              INDEX
                                                                                                               7.00
 LAB SPEC.COND. (MICROMNOS/CH)
                                                               LANGLIER SATURATION INDEX
                                                                                                               0.19
          PARAMETER
                                              VALUE
                                                                         PARAMETER
                                                                                                            VALUE
                                             6,63 F
                                                             CNDUCTVY, FIELD MICROMHOS
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
LEAD, DISS (MG/L AS PB)
TEMPERATURE, AIR (C)
                                                                                                            677.
                                                                                                          324.
FIGURE ON
                                               ₹.03
₹.002
                                                                                                             <.01
ALUMINUM,
               DISS (MG/L-AL)
SILVER, DISS (HG/L AS AG)
DORON (DISS (HG/L AS B)
CADHIUM, DISS (HG/L AS CD)
                                                                                                              .04
                                               . žš
                                                              STRONTIUH, DISS (HGZL-SR)
TITANIUM DIS(HGZL AS TI)
                                                                                                               .59
                                                                                                             <.001
CHRONIUM, DISS (MG/L-CR)
COPPER,DISS (MG/L AS CU)
LITHIUM,DISS(MG/L AS LI)
                                               2.002
3.002
0.047
                                                             VÀNADIUM, DISS (MGZL AS V)
ZINC, DISS (MGZL AS ZN)
ZIRCONIUM DIS(MGZL AS ZR
                                                                                                             <.001
                                                                                                             5.00
                                                                                                              <.003
MOLYBRENUH, DISS(MG/L-HO)
                                                < . 02
```

REMARKS: WATER CLOUDY \*TASTE AND SHELL OK\*LIGHT BROWN SILTY FILTER OWNERS ADDRESS STOCKETT\*RUNNING WATER CLEAR FOR 7 HIN\*FLOW 16.4 GPM\* WATER BECAME VERY CLOUDY AND FLOW 7.2 GPM FOR 8 MIN\*NATER CLEARED

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, HFQ/L MILLIEQUIVELENTS PER LITER, FT = FEET, HT = METERS, (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL,

OW NA S2 NI ON FW AT OTHER OTHER AVAILABLE DATA Y OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 30-JUL-82 BY: TP \*RCS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MED/L (FOR PIPER PLOT)
CA MG NA K CL 904 HC03 C03
45.3 40.1 12.4 2.2 1.1 11.0 87.8 0.0

WATER QUALITY ANALYSIS LAR NO. 8200504

```
COHUTY CASCADE
                                 AUNTANA
                                 47D24'24'N 111D09'38'W
                                                                         SITE LOCATION 120 AF 13 AAFIR
   LATITUDE - LONGITUDE
       UTH COORDINATES
TOPOGRAPHIC HAP
                                                                              MRMG STIC
STATION ID 4/24/4111093803
                                 SOUTHEAST GREAT FALLS 7 1
       GEOLOGIC SOURCE
DRAINAGE BASIN BB
                                                                         SAMPLE SOURCE WELL
                                                             LAND SHREACE ALTITUDE
SUSTAINED YIELD
                                                                                                 3455.
                                                                                                            FI
                                                                                                                    10
      AGENCY + SAMPLER
BOTHE HUMBER
                                 MRHG*WJD
                                                                                                            GEn
                                 LYNCH
                                                                   YIELD HEAS HETHÖD BUCKET/STOPWATCH
            DATE SAMPLED 18-JUN-82
TIME SAMPLED 09:30 HOURS
                                                              TOTAL REPIR OF WELL
ABOVE(-) OR BELOW GS
CASING PIAMETER
                                                                                                  168. FT (E)
169 78 CT (h)
                                                        SWL
       LAR + ANALYST MRMG*FNA
DATE ANALYZED 14-JUL-8:
SAMPLE HANDLING
METHOD SAMPLED PUMPED
                                                                                                  6 111
                                                                      CASING TYPE
                                 14- JUL - 82
                                                                                               STEEL
                                                              PERFORATION INTERVAL
                 WATER USE
                                DOMESTIC
           SAMPLING SITE MIDDLE OF FIELD & OFF TRACY-SAND COULER RD
       GEOLOGIC SOURCE
                                  MG/L
                                                                                                 60/1
                                                                                                             HERZI.
                                                HEQ/I
                                    87.8
                                                                                  (HC03)
                                                                                                                4.29
                      (CA)
                                                    4.38 BICARBONATE
                                                                                                 201.0
      CALCIUM
                                                    2.60 CAREDNATE
0.57 CHLORIDE
                                                                                                    2.2
                                    31.6
                                                                                   (003)
      MAGNESIUM (MG)
                                                                                                                0.26
                                                                                     (CL)
      SODIUH
                      (NA)
                                    13.1
      POTASSIUM
                                     2.7
                                                   0.07
                                                           SULFATE
                                                                                   (SD4)
                                                                                                 148.
                       (K)
                                     <.002
                                                                                                     . 44
                      (FE)
                                                                                  (GS N)
                                                           NITRATE
                                                                                                                 0.03
      ILON
                                                                                      (F)
      MANGANESE
                                                                                                      .52
                                       .001
                                                           FLUORIDE
                      (NN)
                                                    0.00
                                                                                                                 0.03
      SILICA (SIO2)
                                    13.1
                                                           PHOSPHATE TOT (AS P)
                                                                                                                 7.69
         TOTAL CATIONS
                                                    7.62
                                                                        TOTAL ANIONS
         STANDARD DEVIATION OF ANION-CATION BALANCE
                                                                                (SIGMA)
                                                                                                     0.31
                                                                  TOTAL HARDNESS AS CACO3
                         LARORATORY PH
                                                                                                          349.30
                                                     7.45
 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT LAR SPEC.COND. (MICROMHDS/CM)
                                                                                                          214.55
0.31
6.26
                                                               TOTAL ALKALINITY AS CACO3
                                                              SONTH ADSORPTION RATIO
RYZNAR STABILITY INDEX
LANGLIER SATURATION INDEX
                                                  435.33
                                                  568.06
                                                                                                              0.27
                                                  675.1
                                                                        PARAMETER
                                                                                                          VALUE
                                             VALUE
                                                                                                            7.51
                                             700.
                                                             FIELD PH
CNDUCTVY, FIELD HICROMHOS
                                                             ALUMINUM, DISS (MG/L-AL)
SILVER, DISS (MG/L AS AG)
RORON , DISS (MG/L AS R)
CADMIUM, DISS (MG/L AS CD)
CHROMIUM, DISS (MG/L CR)
ALKALINITY, FLD (AS CACO3)
NICKEL, DISS (MG/L AS NI)
                                                                                                            .03
                                            216.
                                               <.01
                                                                                                             ..002
NICKEL PILSS (MG/L AS RI)
LEAD, DISS (MG/L AS PR)
STRONTIUM, DISS (MG/L AS TI)
TITANIUM DISS (MG/L AS TI)
VANADIUM, DISS (MG/L AS V)
ZINC, DISS (MG/L AS ZN)
ZIRDONIUM DISS (MG/L AS ZR)
                                                                                                            <.02
                                                . 89
                                                                                                            <.002
                                                1028
                                                                                                            < .002
                                                             COPPERIDISS (HG/L AS CU)
LITHIUH, DISS (HG/L AS LI)
                                                                                                            .005
                                               <.001
                                                                                                            .022
                                               1.14
                                               <.003
                                                             HOLYBRENUM, RISS (HG/L-HO)
              RENEE LYNCH*DOX 71*SAND COULEE*LOG UNKNOWN*DRILLED MARCH 1944
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REMARKS: FILTER CLEAN\*WATER CLEAR

EXPLANATION: HG/L = MILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, MEG/L HILLIERWIVELENTS PER LITER, ET = FEET, HI = HETERS. (H) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

S2OU FW AT OTHER UW WA

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: PROCESSING PROGRAM: 30-301-82 BY TF: #805 F1730P V2 27 MAY-83 (11/3/81)PRINTED:

> PERCENT HEQ/L (FOR RIPER PLOT) CA CL S04 HC03 អច 003 NA К 7.5 0.9 3.4 40.4 56.2 34.1 0.0

IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8200504 NOTE:

MONTANA RUREAU OF MINES AND GEOLOGY BUTTE, MONTANA 59701 (406)496-4101 WATER QUALITY ANALYSIS LAB NO. 8200505

STATE HUNTANA LATITUDE-LONGITUDE 47D23'05'N 111D11'40'W COUNTY CASCADE SITE LOCATION 19N 04E 23\*CHBA MRHG SITE

MRHG SITE

ALLS 7 1 STATION ID 472305111114001

\* SAMPLE SOURCE WELL

LAND SURFACE ALTITUDE 3770, FT < 10

SUSTAINED YIELD 4.7 GPH UTH COORDINATES Ν Г SOUTHEAST GREAT FALLS 7 1 217KGTN\*220JRSC\* \* TOPOGRAPHIC HAP GEOLOGIC SOURCE
DRAINAGE BASIN
AGENCY + SAHPLER
BOTTLE NUMBER
DATE SAHPLED
TIME SAMPLED E: E: BUCKET/SIDEWATCH **MRHG\*WJB** SUSTAINS TIELD
YIELD MEAS METHOD
TOTAL BEPTH OF WELL
SWL ABOVE(-) OR BELOW GS
CASING DIAMETER
CASING TYPE
COMPLETION TYPE SWARTZB 22-JUN-82 18:30\_HOURS 2485 170 FT (R) FT (R) LAB } ANALYST DATE ANALYZED SAHELE HANDLING METHOD SAHELED HBHG\*FNA 1.5 II STEEL TH (R) 16-301-82 0.1.\* PUMPED PERFORATION INTERVAL WATER USE DOMESTIC

SAMPLING SITE SWARTZENBURGER, GERALD\* GEOLOGIC SOURCE KOOTENAL EGRHATION

	HG/I.	HE.R/L			HG/L	HERZL .
CALCIUH (CA)	46.5	8.35	BICARBONATE	(HCO3)	516.	8.45
HAGNESIUM (HG)	78 <b>-</b> 8	6.48	CARBONATE	(003)	0.	
SODIUM (NA)	11.0	0.48	CHLORIBE	(CL)	3.8	0.11
POTASSIUM (K)	3.2	0.08	SULFATE	(504)	23.7	0.49
IRON (FE)	<.002		NITRATE_	(AS N)	4.27	0.31
MANGANESE (MN)	<.001		FLUORIDE	(F)	1.4	0.07
SILICA (SIO2)	6.5		PHOSPHATE TOT	(AS P)		
TOTAL CATIONS		9.36	TOTAI.	SHOINA		9.44

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGNA) 0.30

LABORATORY PH	7.70	TOTAL HARDNESS AS C	CACO3 440.45
CIELD WATER TEMPERATURE		TOTAL ALKALINITY AS C	CACO3 423.21
CALCULATED DISSOLVED SOLIDS	433.38	SODIUM ADSORPTION R	ATIO 0.23
SUH OF DISS, CONSTITUENT	675.19	RYZNAR STABILITY I	NDEX 6.71
LAB SPEC.COND.(HICROHHOS/CH)	793.3	LANGLIER SATURATION I	NDEX 0.49

PARABETER	VAL.UE	PARAHETER	VALUE
TEHPERATURE, AIR (C)	72. F	CNDUCTVY, FIELD HICROPHOS	796.
CIEUD PH	7.17	ALKALINITY,FLD(AS CACO3)	433.
ALUHINUH, DISS (HG/LHAL)	<.03	NICKEL,DISS (HG/L AS NI)	01
SILVER,DISS (MG/L AS AG)	<.002	LEAD, DISS (MG/L AS PB)	€.04
DORON JDISS (MG/L AS E)	<.02	STRONTIUM,DISS (MG/L-SR)	.48
CADHIUH, DISS(HG/U. AS CD)	<.006	TITANIUH DIS(MG/L AS TI)	.003
CHRONIUM, DISS (MG/L-CR)	<.002	VANADIUH,DISS(HG/L AS V)	<.001
COPPER-DISS (MG/L AS CU)	<.001	ZINC:DISS (MG/L AS ZN)	• 33_
LITHIUM, DISS(MG/L AS LI)	.046	ZIRCONIUH DISCHG/L AS ZR	₹.003
MOLYBDENUM, DISS(MG/L-MO)	<.02		

REMARKS: FILTER COVERED WITH SILT \* WATER CLOUDY CERALD SWARTZENRURGER \* SAND COULEE MT

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MER/L MILLIEQUIVELENTS PER LITER, FT = FCET, MT = METERS. (M) = MEASURED, (E) = COTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA S2 WI OW PW AT OTHER OTHER AVAILABLE DATA Y OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 05-JAN-83 RY: TP \*TP
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K CL SO4 MC03 CO3
24,8 69.0 5.1 0.9 1.0 5.4 93.4 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAW NUMBER: 8200505 Reads

BUTTE-MONTANA SSZOL (406)456 4101 WATER QUALITY ARAL :5/5 STATE MONTANA COURTY CAUCAME 47023:32°N 111008:38°W LATITUDE-LONGITUDE SILE LOCATION 198 GSL 18 BEDE HANG SITE STATION ID 42233. LL1003601 UTH COORDINATES 14 SOUTHEAST GREAT FALLS 7 : TOPOGRAPHIC MAP TOPUGRAPHIC THE SUCTIONS SECOND SOLUTION STATES AGENCY + SAMPLER MAMGAHRM FOTILE NUMBER CENSECT THATE SAMPLED 29 DEC 82 TIME SAMPLED 10:45 HOURS A SAMPLE SOURCE WELL LAND SURFACE ALTITUDE 347 SUSTAINED YJELD \* 3:75.0 FT YIELD MEAS METHOD TOTAL REPIR OF WELL SWL ABOVE( ) OR BELOW GS .00. FT (R) 1.00% FUC IN (M) LAB + ANALYST MBMG\*FNA DATE ANALYZED 19-JAN 83 SAMPLE HANDLING CASING DIAMETER CASING TYPE 19-JAN 83 \* METHOD SAMPLED PUMPED PERFORATION INTERVAL WATER USE DOMESTIC SAMPLING SITE CENTERVILLE SENTOR CITIZENS CENTER GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE n6/L MEGIL MG/L ME Q/L 241. 12.03 BICARBONATE (HC03) 105. CALCIUM (CA) 6.04 135. (003)Ô. CARBONATE HAGNESIUM (MG) 11.11 755. 0.66 15.72 0.89 SODIUM 1.00 CHEORIDE (CL) (NA) (\$04) (AS N) FOTASSIUM (K) (EE) 4.1 SULFATE 0.11 ..002 NIIRATE TRON HANGANESE 0.00 FLUORIDE (F) (MM) .004 0.03 SILICA (SIDE) 16.5 PHOSPHATE TOT (AS P) TOTAL CATIONS 24,24 23.26 TOTAL ANIONS STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) -0.63 LABORATORY PH 5.52 1157.44 TOTAL HARDNESS AS CACOS FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS SUM OF DISS. CONSTITUENT 6.8 C TOTAL ALKALINITY AS CACO3 1411.11 SODIUM ADSORPTION RAILO 332.17 0.30 1616.90 RYTNAR STABILITY INDEX 6.57 1701. LANGLIER SATURATION INDEX LAB SPEC, COND, (HICROMHOS/CM) -0.03PARAMETER VALUE PARAMETER VALUE F. ENDUCTVY, FIELD HICROMHOS ALKALINITY, FLD (AS CACO3) TEMPERATURE, AIR (C) 20. 5.70 1530. 361.00 FIELD PH DISS\_(MB/L-AL) . . 63 NICKELIDISS (MG/L AS NI) LEADIDISS (MG/L AS PE) .01 ALUMINUM? SILVER, DISS (NG/L AS AG) DORON , DISS (MG/L AS B) CADMIUM, DISS (MG/L AS CD) <.002 (MG/L AS PE) ..04 .82 .024 STRONTIUM, DISS (MG/L-SR) · 1 1 .002 TITANIUM DIS(MG/L AS TI) VANAUTUM,DISS(MG/L AS V) VANABLUM, DISS (MSZL AS V) ZINC, DISS (MGZL AS ZN) ZIRCONTUM DIS(MGZL AS ZR ARSENIC, DISS(UGZL AS ZR CHROMIUM, DISS (MG/L-CR) COPPER,DISS (MG/L AS CU) LITHIUM,DISS(MG/L AS LI) .004 .004 .038 .034 .003 .046 HOLYBRENUM; DISS (MG/L-MO) ARSENIC, DISS(UG/L AS AS) . 0 <.02 REMARKS: WHITE FOAM COATS STEEL TAPE: DRIES TO HARD WHITE PPI,, FILTER CLEAN EXPLANATION: MGZL = MILLIGRAMS PER LITER, UGZL = MICROGRAMS PER LITER, MERZL MILLIERUTVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED. (E) = ESTIMATER, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL. S2 OW F. W OTHER UM WA W T AI OTHER AVAILABLE DATA OTHER FILE NUMBERS: COST:

PROJECT:

COST:

LAST EDIT DATE: 02-FFB-03 RY: TF \*RCS

PROCESSING PROGRAM: F173OF V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT MED/L (FOR FIFER FLOT)

PERCENT MEQ/L (FOR PIPER PLOT)
CA MG NA K UL SO4 HCO3 CO3
49.6 45.8 4.1 0.4 2.9 68.3 28.8 0.0

MONTANA BUREAU OF MINES AND GEOLOGY 59701 (406)496-4101 BUTIE - MONTANA

#### WATER QUALITY ANALYSIS LAB NO. 8300002

STATE MONTANA COUNTY CASCADE 47D24152\*N 111D08155\*W SITE LOCATION 19N SE LATTTUDE-LONGITUDE 7 \* B D D C UTH COORDINATES N MRMG SITE SOUTHEAST GREAT FALLS 7 1 STATION ID 472452111085501 TOPOGRAPHIC MAP GEOLOGIC SOURCE DRAINAGE BASIN AGENCY + SAMPLER BOTTLE NUMBER SAMPLE SOURCE WELL 330MDSN\* LAND SURFACE ALTITUDE SUSTAINED YIELD BB3455. FT < 10 MEMG\*HRM YIELD MEAS METHOD
TOTAL DEPTH OF WELL
SWL ABOVE(-) OR RELOW GS
CASING DIAMETER
CASING TYPE GHEAL-2 DATE SAMPLED 30-DEC-82 220.0 (E) 11:30 HOURS (H) LAR + ANALYST DATE ANALYZED SAMPLE HANDLING ลหา\*อัหล์ห (M) III 8 **IRÖN** 19-JAN-83 \* HETHOD SAMPLED PERFORATION INTERVAL PUMPED WATER USE STOCK SAMPLING SITE HEAL WELL-2 TRACY SCULOGIC SOURCE MADISON GROUP OR LIMESTONE MG/I MEQ/L HEO/L MG/1. 97.3 89.4 CALCIUM 233.0 (CA) 4.86 BICARBONATE (HC03) 3,83 MAGNESTUM (MG) 7.35 CARRONATE (003) 0. 22.0 SODIUM (NA) 0.96 CHLORIDE (CL) 13.8 0.39 8.91 SULFATE NITRATE (K) POTASSIUM 8.0 0.21 (S04) 428 -<.002 IRON (FE) (AS N) 1.83 (MN) .003 MANGANESE .55 0.00 FLUORIDE (F) 0.03 SILICA (3(02) 8.7 PHOSPHATE TOT (AS P) TOTAL CATIONS TOTAL ANIONS 13.37 13.29 STANDARD DEVIATION OF ANION-CATION BALANCE -0.07 (SISMA) 7,56 7,3 C 784,76 TOTAL HARDNESS AS CACO3 TOTAL ALKALINITY AS CACO3 LABORATORY PH 610.93 FIELD WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS 191.76 SONJUM ANSORPTION RYZNAR STABILITY LANGLIER SATURATION RATID SUM OF DISS. CONSTITUENT 903.38 6.90 INDEX 1115. SPEC.COND. (MICROMHOS/CM) INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, ATR (C)	30.0 F	CNDUCTVY/FIELD MICROMHOS	1151.
FIELD PH	6.80	ALKALINITY, FLD (AS CACO3)	205.00
ALUNINUM, DISS (MS/L-AL)	< € 0.3	NICKEL/DISS (MG/L AS NI)	<.01
SILVERIALSS (MG/L AS AG)	<.002	LEAD, DISS (MG/L AS PE)	<.04
DORON FOISS (HG/L AS B)	.10	STRONTIUM,DISS (MG/L-SR)	• 8 &
CABHIUM-BISS(MOZL AS CD)	C • 0 0 C	TITANIUM DIS(MG/L AS TI)	.010
CHROMIUM, DISS (MG/L-CR)	<.002	VANADIUM;DISS(MG/L AS V)	.002
COPPER-BISS (MG/L AS CU)	s Ø Ø 8	ZINC>DISS (MG/L AS ZN)	.015
LITHIUH/DISS(MG/L AS LI)	.053	ZIRCONIUM DIS(MG/L AS ZR	<.003
MOLYBRENUM, RISS(MG/L-MO)	<.02	ARSENIC∙DISS(UG/L AS AS)	. 3

REMARKS: CLEAR

FILTER A LITTLE YELLOWISH, VERY FINE SILT ON FILTER AND SAND

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L HILLIERUTVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW. \$2 WI FW MA 0.9AID DIHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST: LAST EDIT DATE: :MARGORS ONTESSOOR 02-FEB-83 BY: TP \*BCS E17308 V2 PRINTED: -(11/3/81)27-MAY-83

> PERCENT MEDZIL (FOR PIPER PLDT) CÊ SO4 HCO3 CA MG K 0.03 36.3 55.0

WATER GUALITY AMALYSIS LAR NO. 8380003

COUNTY CASCADE SIA!E MONIANA SITE LOCATION 19N 04E 13 AAAD LATTIUME LONGTIUME 47024/21\*N 111D09/16\*W UTH COORDINALES STATION ID 47742111109160; PLE SOURCE WELL TOPOGRAPHIC MAP SOUTHEAST GREAT FALLS 7 1 COLOGIC SOURCE DRAINAGE BASIN SABELE SCOLOGIC 330HDSN\* SURFACE ALTITUDE SUSTAINED YIELD YIELD MEAS METHOD LAND 3110. F: E FI 10 AGENCY + SAMPLER BOTTLE NUMBER DATE SAMPLED MRMS\*HRM DATE SAMPLED 20-DEC-82 TIME SAMPLED 15:00 HOURS LAR + ANALYST MRMG\*FNA DATE ANALYZED 19 JAN 83 SAMPLE HANDLING METHOD SAMPLED TOTAL DEPHLOF WELL ABOVE( ) OK BELOW OS CASINS DIAMETER 170.0 FT (R) SWI 7 3H (R) CASING TYPE
COMPLETION TYPE
PERFORMION INTERVAL IRON 10# WATER USE DOMESTIC

SAMPLING SITE M NAVULA, STAR RT, SAND COULEE, N OF 7 SIDING GEOLOGIC SOURCE MADISON GROUP OR LIMESTONE

	MG/I	MEQ./T			M6/1	MERZI
(A) HUIDIA	118.	5.87	THARDMAND	CHCG3D	740.1	3.93
MAGNESTUM (MG)	36.0	2.96	CARRONATI	((03)	0.	
SOFIUM (NA)	16.7	0.74	CHLORIBE	(CL)	.5.0	0.17
POTASSIUM (N)	3.4	0.07	SULFATE	(SA4)	252.	5.25
IRON (FE)	,008	0.00	NITRATE	(AS N)	3.85	0.27
HANGANESE (MN)	.004	0.00	ELUORIDE	(F)	.32	0.02
SILICA (SIGE)	14.7		PHOSPHATE TOT	(AS E)		
TOTAL CATIONS		9.67	TOTAL	SKOIKA		7.61

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA) 0.12

H3 YROTARORAL	7.4	TOTAL HARDNESS AS CACOS	412,82
FIELD WATER TEMPERATURE	3.7 0	TOTAL ALKALINITY AS CACG3	198.92
CALEBRATER DISSOLVED SOLIDS	569:46	SODIUM ADSORPTION RATIO	0.35
SUM OF DISS. CONSTITUENT	391.28	RYTHAR STABLLITY INDEX	৬.87
LAE SPEC.COND.(HICROMHOS/CH)	829.3	LANGLIER SATURATION INDEX	0.27

PARAMETER	VALUE	PARAHETER	VALUE
TEMPERATURE, AIR (C)	25. 1	CARUCTVY, ETELD MICROMHUS	778.
FIELD PR	6.10	ALKALINTIY>CLB(AS CACO3)	220.
ALUMINUM, DISS (MG/L AL)	. 0.3	NICKEL/DISS (MOZI AS NT)	.02
SILVER-DISS (MSZL AS AS)	√.007	LEAD-BISS (HS/L AS CD)	04
BORON (DISS (MG/L AS E)	.10	GTEONTIUM,DISS (MG/L-SR)	.67
CADHIUH,DISS(HS/L AS CD)	.003	TITANIUM BIS(MS/L AS II)	.014
CHROHIUM, DISS (MG/L-CR)	1.000	VANADIUH,DISS(HSZL AS V)	.001
COPPERIDISS (MG/L AS CU)	.014	ZINC:DISS (MG/L AS ZN)	.49
EITHIUM, DISS(MG/L AS LI)	.016	ZIRCONTUM BISCHSZL AS ZR	.003
HOLYBRENUM, DISS(MG/L-MO)	<.02	ARSENIC, DISS(US/L AS AS)	. 1

REHARKS: INITIAL TAP WATER RUSTY COLOR FOR 5 SEC, FILTER ALSO RUST COLORED

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, HEG/L HILLIEROIVELENTS PER LITER. ET = FELT, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QW WA SO WE OW PW AT OTHER OTHER AVAILABLE BATA Y OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 01-FEB-03 RY: IF \*BCS
PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTED: 27 MAY 83

OFRICANT MEDZE (FOR PIPER DEGT)

CA MG NA N CL 504 HC03 CG3

60.2 30.8 7.8 0.2 1.8 58.1 42.1 0.0

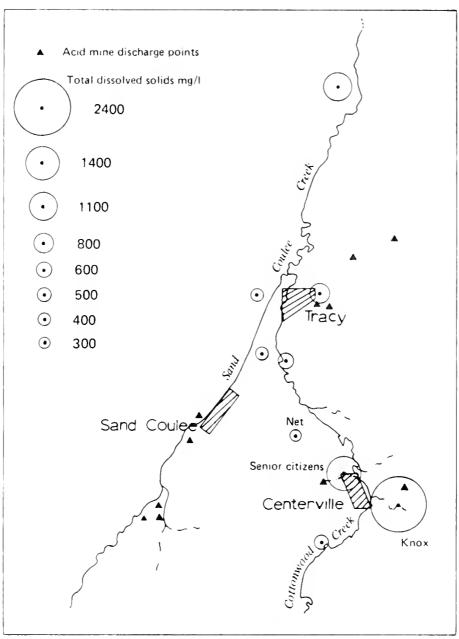


Figure C-3. Location of acid discharge points and total dissolved solids in Madison wells.

APPENDIX D
SURFACE WATER DATA

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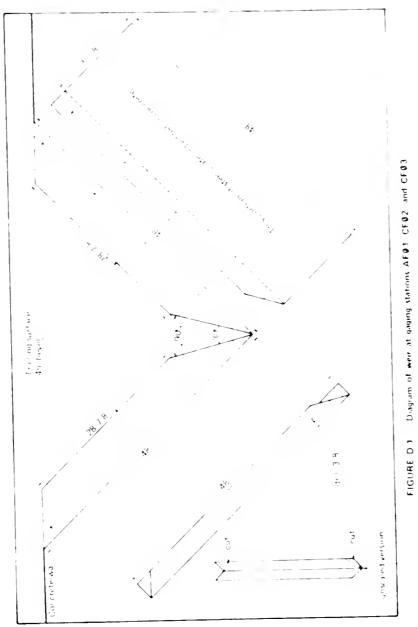


FIGURE D.1 — Diagram of weir at gaging stations AFQ1 CFQ2 and CFQ3

The discharge rating equations are
For gage heights (g.h.) < 1.12ft O(Itt<sup>1</sup>'s.) = (0.49 + (g.h.)<sup>2.5</sup>

For gage heights (g.h.) < 2.1.2ft O(Itt<sup>1</sup>'s.) = (2.49 + (i.g.h.) 0.8176)<sup>2.48</sup>) + 0.7545

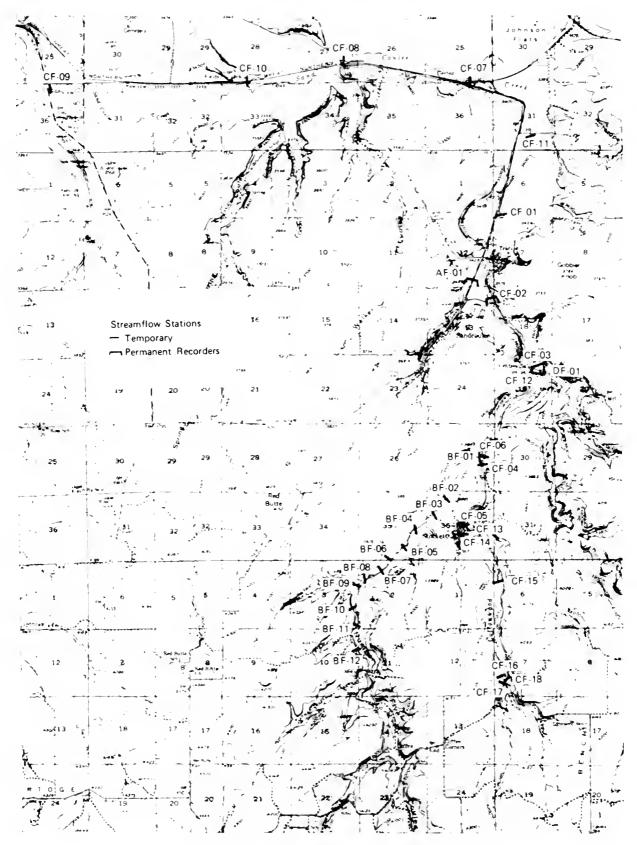


Figure D-2. Streamflow stations established for seepage profiling.

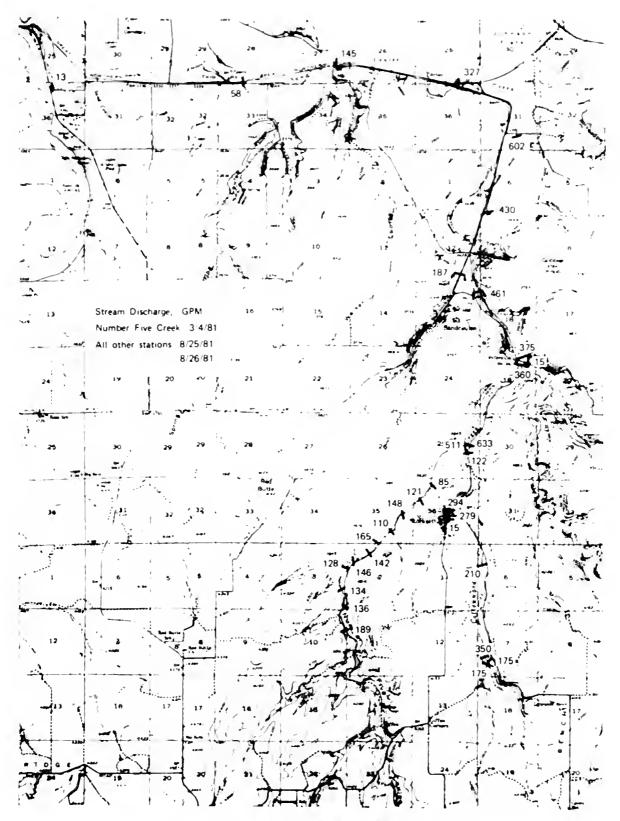


Figure D-3. Streamflow quantities measured in 1981.

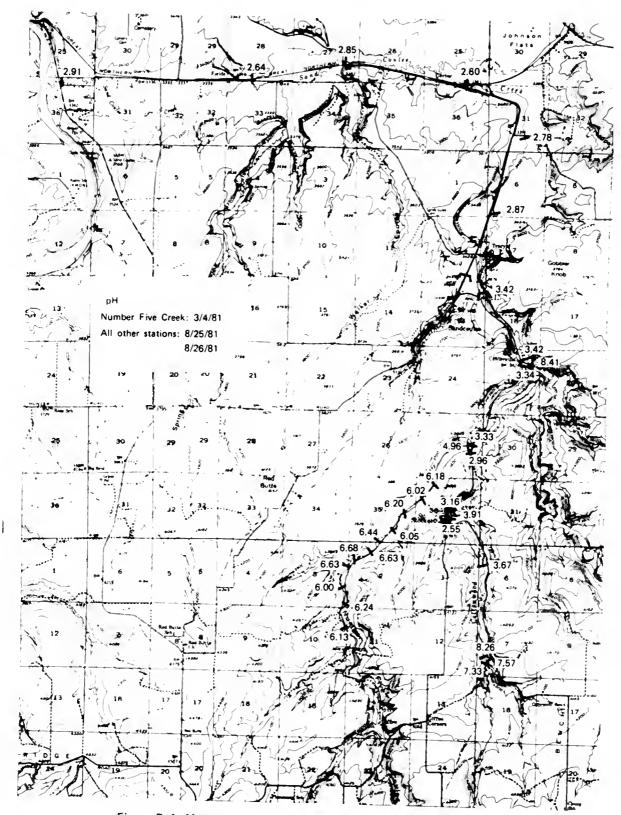


Figure D-4. Measurements of pH at the time of streamflow measurement.

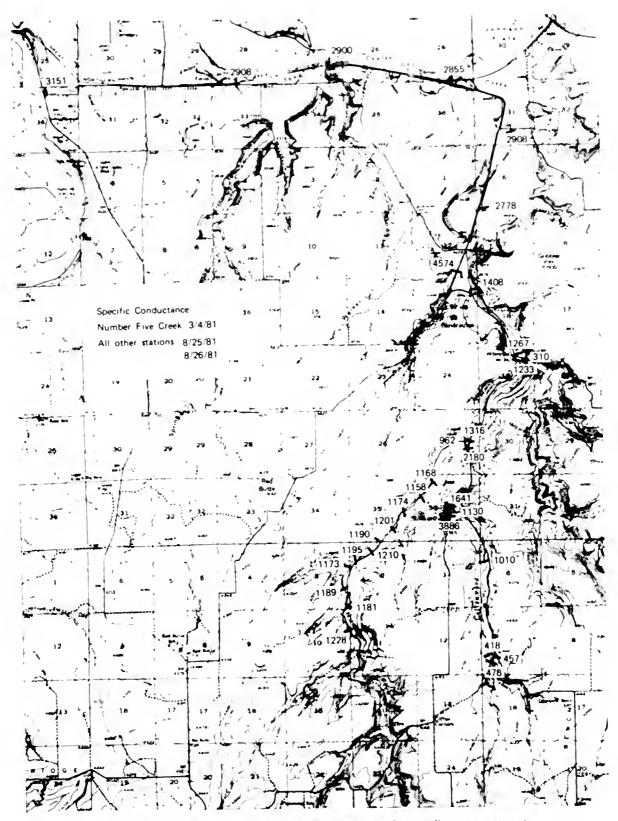


Figure D-5. Specific conductance values at the time of streamflow measurement.

8
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6.4
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11

WATER RUAL DIY ARM YOU LAB NO. 010:005

COUNTY CASCAME
7/42\*W SITE LOCATION 17H OFF 13 ARABE
7/55 HEMO SITE AL OL
ALLS 7 L STATION IN 473424111094201

# SAMPLE SOUNCE STREAM
LAND SURFACE ALTITUDE 3435.
WATER LOW RATE 507. GEM
LEOW MAS ALTHOR WEIT MONTANA 4/001/01/N | 111009/10/N 710 | N5050170 | E48/795 SOUTHEAST GREAT FALLS 7 | STATE LATTIUDE LONGITUDE UTH COORDINATES TOPOGRAPHIC MAP GEOLOGIC SOURCE DRAINAGE BASIN \* B I: AGENCY / SAMPLER MAMG\*ADM RUMRER ACTOR SAMPLED 15 JUL DATE SAMPLED 15 JH 01 TIME SAMPLED 14:00 HOURS TOWN THIS TO THE CASE
STATE OASE
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HERRITOR OF HERRITOR
HERRITOR MATER 1.34 LAN ( ANALYST DATE ANALYZED SAMPLE HANDING MEMS\*ENA HELHOR SAMPLER GRAD

WATER USE UNUSED

SAMPLING SITE SAME COULFL MINING BISTPICT\*NO NAME ERFLE DRAINAGE BASIN MISSOURI RIVER BELWELN MARIAS RIVER AND LITTLE CRICLLY OF

CALCIUM (CA) MAGNESTUM (MG) SODIUM (NA) FOTASSIUM (K) IRON (FC) MANGANESE (MN) SULICA (SID2)	MS/L 134. 137. 23.4 3.3 104. 1.46 55.4	11:07 1:00 0:08 0:78	BICARDONATE CARBONATE CHUCKIDE OULFATE NITWATE FLUCKIDE PHOSPHATE TOT	(HC03) (E03) (CL) (C04) (AS H) (E) (AS E)	MGZI .0 .0 7.5 3240. 2.12 7.17	0.01 02.03 02.15 0.30
TOTAL CATIONS		43.39	TOTAL	ANTONO		02.77

STANDARD DEVIATION OF ANION CATION MALANCE (SIGHA)

2.61 LABORATORY PH TOTAL HARDNESS AS CACOS 973.40 FIFE D WATER TEMPERATURE CALCULATED DISSOLVED SOFIDS SUM OF DISS. CONSTITUENT LAB SPEC.COND.(MICROHNOS/CM) TOTAL ALKALTHITY AS CACCS
SOBTUM ADSORPTION RATIO
RYZNAR STABULITY INDEX 23.7 0.33 LANGETER SATURATION THEFY 4243.

VALUE PARAMETER PARAMETER VALUE 25. CNDUCTVY, FIFL B HICROPHOS ALUMINUM, DISS (MG/L AL) TEMPERATURE, AIR (C) 3748. ALUMINUM, DISS (MG/L AL)
STEVER, DISS (MG/L AS AG)
SORON , DISS (MG/L AS AG)
CAPHIUM, DISS (MG/L AS CH)
CHROMIUM, DISS (MG/L AS CH)
CHROMIUM, DISS (MG/L AS CH)
COPPER, DISS (MG/L AS CH) ETHER PH 342. HICKELIDISS (MG/L AS NI) LEADIDISS (MG/L AS PB) 1.51 .000 . . 04 .12 STRUNTTUH, DISS (HGZL -SR) TIFANTUH DISCHGZ AS TI) VANADIUH, DISS (HGZL AS V) LIFHTUH, DISS (HGZL AS LI) 1.09 .014 .044 510. 20 HOLFERTHERS (HOVE HO)
HOLFERTHER (HOVE HO)
GELENIUM, TR (UOVE AS SE)
ACIDITY, TOT (MG/L CACO3) .52 421, 238. IRON+TE (HGZL AS FE) . 0 3000. ALUMINUM, TR (HG/L AS AL) ZINC: DIGS (HG/L AS ZN) 7.72 ZURCONIUM DUS(MS/L AS ZE .003

PEHARNS: WATER HUDDY AND RUSTY COLOR NO NAME CREEK GAGING STATION AF-01 LAR: H: 60.88 MG/L GIVES 80.25 MEQ. CATIONS GIVES 1.31 SIGHA

EXPLANATION: MG/L = MILLIGRAMS PER LIFER, US/L = MICROSRAMS PER LIFER, MEG/L MILLIFOUTVELLINTS PER LIFER. ET = FEEL, MI = METERS. (H) = MEASURED, (F) =ESTIMATER: (R) = REPORTER. TOT = TOTAL . TR = TOTAL RECOVERABLE.

> 30 OW FW AT. DIREC

OTHER AVAILABLE BATA OTHER FILE NUMBERS:

PROJECT: cost: FBIT BAIE: 19 FEB 82 NG PROGRAM: F1730F V2 (11/3/81) LAST FRIT DAIE: PROCESSING PROGRAM: TO #UNS DZ MAY 63 SY FRINIFFE

> PERSONAL MESAL (FOR PIPER PLOT) CA HG NA - }. CI. **304 HC03** 37.3 54.8 5.0 0.4 0.3 22.7 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 0101005 | Dec

# WATER QUALITY ANALYSIS LAB NO. 8181511

STATE HONTANA COUNTY CASCADE LATITUDE - LONGITUDE 42D23123\*N SITE LUCATION 17N SE 17 AACA \_\_tjtD08/24\*W UTH COORDINATES TOPOGRAPHIC HAP | MBMG SITE CF-03 | STATION IN 472323111082401 IJ F HAF SGUTHEAST GREAT FALLS 7 1 GEOLOGIC SOURCE DRAINAGE BASIN \* SAMPLE SOURCE STREAM LAND SURFACE ALTITUDE 34 WATER FLOW RATE 3 FLOW MEAS\_METHOD WEIR B D 3464. FT < 10 AGENCY & SAMPLER DOITE NUMBER MEMS\*JLS 375. GE:H 27-AUS-81 PEOW MEAS METHOR STAFF GAGE STREAM STASE DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM WIDTH DATE SAMPLED TIME SAMPLED LAB + ANALYST DATE ANALYZED SAMPLE HANDLING 11:00 KÖÜRS HEHG\*FNA 1.1 FT (H) RETHOD SAMPLED GRAD

WATER USE UNUSED

SAMPLING SITE SAND COULEE CREEK AT CENTERVILLE SCHOOL \*
DRAINAGE BASIN MISSOURI RIVER BETWEEN MARJAS RIVER AND LITTLE PRICKLY #

	HG/I.	HEQ/L			HSZI.	HEGZE
CALCIUM (CA)	1.15.	7.24	BICARBONATE	(RC03)	.0	
KAGNESIUM (HG)	58.0	4.77	CARBONATE	(003)	. 0	
GBRIUM (NA)	15.2	0.55	CHLORIDE	(CL)	6.8	0.17
POTASSTUM (K)	4.5	0.13	SULFATE	(SO4)	857.	17.84
IRON (FE)	10.1	0.54	NITRATE	(AS N)	1.75	0.14
HANGANESE (HN)	• 85	0.03	FLUCRIDE	(F)	1.43	0.08
STEDA (SID2)	16.6		PHOSPHATE TOT	(AS E)		
TOTAL CATIONS		13.37	TOTAL	ANIONS		18.25

STANDARD DEVIATION OF ANION-CATION BALANCE (SIGMA)

LABORATORY PH 3.35 TOTAL HARDNESS AS CACO3 600.79
FIELD WATER TEMPERATURE 19.6 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SODIUM ADSORPTION RATIO 0.27
SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(HICROMHOSZCM) 1567, LANGLIER SATURATION INDEX

PARAMETER	VALUE	PARAMETER	VALUE
TEMPERATURE, AIR (C)	22. 0	CNDUCTVY/FIELD HICROMHOS	1267.
FIELD PH	3.42	ALUHINUH, DISS (MG/L-AL)	39.6
RICKEL+DISS (MG/L AS NI)	• 50	SILVERFDISS (HG/L AS AS)	<.002
LEAD. DISS (MGZL AS PB)	<.04	BORON →DISS (HG/L AS B)	.05
STRONTIUH,DISS (HS/L-SR)	.42	CADHIUH,DISS(HG/L AS CD)	.013
TITANIUM DIS(HG/L AS TI)	.027	CHRCHIUM, DISS (HGZL-CR)	.010
VANADIUM,DISS(HGZL AS V)	.012	COPPER•DISS (HS/L AS CU)	.008
ZINC, DISS (MG/L AS ZN)	3.77	LITHIUM,DISS(MG/L AS LI)	.005
ZIROONIUH DIS(HGZL AS ZR	.007	HOLYBBENUH, DISS(MG/L-HO)	.03
SELENIUM, DISS (US/L-SE)	<b>→</b> 7	ACIBITY,TOT(MG/L-CACO3)	313.

REMARKS: WATER IS BRIGHT ORANGE \* ABUNDANT FE-HYDROXIDE FLOCOULENT \*
HENG GAGING STATION CF-03 \* 1 FILTER USED \* FRESH FLOC BELOW DE-01
INFLOW \*

LAB: BE 6.30 MG/L SIVVES 19.0 MEG CATIONS GIVES -2.01 SIGMA

EXPLANATION: HOVE = HILLIGRAMS PER LITER, UGVL = HICROGRAMS PER LITER, HEQVL HILLIEOUIVELENTS PER LITER. FT = FEET, HT = HETERS. (H) = HEASURED, (E) = ESTIMATED. (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

QU WA SO NI OW EN AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 19-FER-02 BY: TP \*UNS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27 MAY-03

PERCENT MEQUL (FOR PIPER PLOT)
CA MG NA N DI 904 HC03 C03
56.6 37.3 5.2 1.0 1.1 98.9 0.0 0.0

NOTE: IN CORRESPONDENCE: PLEASE REFER TO LAR NUMBERS: 8101511 D-7

# WATER GUALINY ANALYSIS TAL NO. 81815.0

MGNIANA 47D22/14\*N STATE LONGITURE COUNTY CASCADE COUNTY CAREARS
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COUNTY L(100012814 UTH COOKPINATES Č N E STOCKETI 7 1/2 TOPOGRAPHIC SEGLOGIC SO HAP FOUNGIC SOURCE PRAINAGE BASIN DE DRACKABLE HABIN DE ABENCY ) SAMPLER HABIG\* JUD HOTTLE NUMBER OF GO DITTLE SAMPLED TO AUG OF TIME SAMPLED TO LOS HOUSES LAR I ANALYZED BATE ANALYZED SAMPLE HABILING 3220 HETHOR CARLET GRAD THE BOOKER CASH WOLL BOAR TAKE BOAR MAJERS STEERH STAGE PERTH TO SAMELS TOTAL REPTH OF WATER SIREAH WIDTH

WATER USE UNUSED

METHOR CAMPLER GRAD

SAMELING SITE COTIONWOOD OR DELOW CONFLUENCE W/∳5 CEFEL# DRAINAGE BASIN HISSOURI RIVER BEIWELH HARLAS RIVER AND LITTLE CRICLLY OF

CALCIUM (CA)  MAGNESTUM (MG)  GOUTUM (MA)  FOINSSIUM (K)  IRON (FE)  MANGAMESE (MN)	MG/I 132. 52.8 15.4 -4.8 30.5	4.75 0.67 0.10 1.64	BICARDONALS CARBONATE CHEORIDE SULFATE NITRATE ELUGRIDE EROSEBATE TOI	(F +	850 850 1.33	#1 G :
STUICA (SIGE) TOTAL CATTONS	15.1	14.15		ANIONS		10.12

STANDARD DEVIATION OF ABION CALLON BALANCE (SIGHA)

TOTAL HARBNESS AS CACOS LABORATORY PH 3.64 584.77 FILED WATER TEMPERATURE CALCULATED DISSOLVED SOLIDS 17.9 C TOTAL ALKALINITY AS CACOS SOLIUM ADSORPTION RATIO 0.00 SUM OF BISS, CONSTITUENT LAB SPEC.COND.(MICROMHOS/CM) RYTHAR STABILLLY INDEX LANGLIER SATURATION (HDEX 1499.

PARAMETER	VALUE	CARABITER	VALHE
TEMPERATURE: AIR (C)	18. 0	CHRUCTVY, FIELD MICROSHOS	1316.
LILIB LH	3.33	ALUMINUM+ DISS (MS/L AL)	33.7
NICKEL - DISS (NG/L AS NI)	.87	SILVER:BISS (HS/L AS AS)	.002
LEAD-BISS (MG/L AS PR)	04	RORON FRISS (MG/L AS B)	.06
STRONTIUH,DISS (HGZL-SR)	. 40	CADMIUM•BICSCH67L AS CDD	.017
TITANIUM DES(MG/4 AS TI)	.071	CHRONIUM, DISS (NG/L SD)	.007
VANADIUM,DISS(MS/L AS V)	.006	COPPER,DISS (MOZI AS CU)	.066
ZINC+DISS (MG/L AS ZN)	3.84	LITEBLUM: DIOS (MG/L AS LI)	.ogu
ZIRCONIUH DISCHG/L AS ZR	.008	HOLYFAENUM+DISS(HG/L HO)	. 0.3
SELENTUM, DUSS (UG/L-SE)	• 7	ACTRITY.TOT(HG/L CACO3)	290.

REMARKS: NATER IS BRIGHT DRANGE \* ABUNDANT FE HYDROXIBE FLOCOULDED \*
NO. FIVE CREEK FLOW 511 GEM. FB 4.76, G.C. 762 \* COTTONWOOD CREEK
UPSTREAM FLOW 122 GEM, FB 2.96, G.C. 2180 \*
LAB: HI 5.85 MG/L GIVES 18.3 MER CATIONS GIVES .43 GIOMA

EXPLANATION: MGZI = MILLIGRAMS PER LITER, UGZL = MICROGRAMS PER LITER, MLQ I HILLIGUTVELENTS PER LITER. FT = FECT, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. FR = TOTAL RECOVERABLE. 101 - 103AL.

BIHER OM S ? AT G₩. WA 1.1 T

OTHER AVAILABLE BATA OTHER FILE NUMBERS:

COST: TEO BOT: PROCESSING PROGRAM: 19 FFB 82 E(730F V2 (11/3/81) TP #JNS SYL 27 HAY 83 PRIMIER

> PERCENT HEAVE (FOR PIPER PLOT) CI S04 HC03 003 NA CA HG 1.2 78.8 1.0 55.6 38.1 0.0

HULL: IN CORPESPONDENCE, PLEASE RELIE TO LAB NUMBER: GIRL'S C. R.

# WATER QUALITY ANALYSIS LAB NO. 8181513

LATITUDE O ONGITUDE MONIANA 47026159\*N COUNTY CASCADE 20N 5F CF-07 111D07/24\*W OTTE LOCATION 36 AAA UTH COORDINATES TUPDORAPHIC MAP GCOLOGIC SOURCE BRAINAGE RASIN STIS ONEH RI MOLTATE SORUOC SUMMAS 14 4472659111092401 STREAH 3302. FT < 10 327. GPM SOUTHEAST GREAT FALLS 7 1 SURFACE ALTITURE F: E: LAND AGENCY E SAMPLER REMNUM BLITTON FRANCE SAMPLER WATER FLOW RATE 3 FOW HEAS HETHOD WETE STAFF GAGE #3H6#JLS CF-07 FLOW MEAS 08 AUG-81 TIME SAMPLED LAB : ANALYST DATE ANALYZED SAMPLE HONDLING STREAM STAGE STREAM STAGE JEPTH TO SAMPLE TOTAL BEPTH OF WATER STREAM WIDTH ti:00 Hours H¤HG≭FNA 0.6 FT (H) 4220 HETHOR SAMPLED ORAB

WATER HISE UNHISED.

GAMPLING SITE SAND COULEE CREEK (S.M.L. OF GERBER SIBING DRATHAGE BASIN MICSOUR) RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY PL

CALCIUM (CA) MAGNESTUM (MG) SODIUM (NA) POTASSTUM (N) IRON (FE) MANGANESE (MN) STLICH (STOZ)	MG/L 130. 91.8 17.0 3.4 176. 1.61	7.55 0.74 0.09 10.53	BICARBONATE CARBONATE CHICRIDE SULFATE HITRATE FLUORIDE PHODEHAIC IST	(BC03) (C03) (CL) (CC) (AS N) (AS N) (AS C)	HG/L .0 .0 11.0 0300. 1.07 5.75	0.31 47.89 0.00 0.30
CMOITAD 1ATO1		26.75	TOTAL	ANTONS		48.58

STANDARD DEVIATION OF ANION-CATION RALANCE (SIGHA)

LABORATORY PH 2.89 TOTAL HARDNESS AS CACO3 777.37
FIELD WATER TEMPERATURE 17.0 C FOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS CODIUM ADSORPTION RATIO 0.27
SUH OF DISG. CONSTITUENT RYTHAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOS/CM) 3306. LANGLIER SATURATION INDEX

PARAMETER	VALUE	FARAMETER	VALUE
TEMMERATURE, AIR (C)	18.0 C	CNDUCTVY+FIELD HICROMHOS	2055.
FIELD DH	2.6	ALUMINUH: DISS (MG/L AL)	203.
MICKEL·DIOS (MG/L AS MI)	2.18	SILVER-DISS (HOZE AS AG)	.005
LEAR-DISS (MG/L AS PR)	.04	BORON →DISS (MG/L AS B)	. 1.4
STRONTIUH,DISS (HS/L-SR)	.66	CARMIUM/DISS(MS/L AS CD)	.045
TITAMIUM DIS(MG/L AS TI)	.32	CHROMIUM• DISS (MG/L+CR)	.10
VANADIUH-DISS(HG/L AS V)	.015	COPPER+DISS (HG/L AS CU)	.19
ZINC+DISS (HS/L AS 7N)	9.17	LITHIUH•BISS(MG/L AS LI)	.20
ZIRCONIUH DISCHBZL AS 7N	.019	HOLYRDENHH-DITSS(HG/L-HO)	.00
SELENTUM: BISS (UG/L SE)	• 7	ACIDITY,TOT(HG/L CACO3)	1040.

REMARKS: WATER IS REB BROWN \* LARGE PARTICULATE HYDROXIDE FLOCOULENT \* LARL HI 37.06 MG/L GIVES 53.11 MEG CATIONS GIVES 5.43 SIGMA

EXPLANATION: MG/L = MILLIGRAMS PER LITER, MG/L = MICROGRAMO PER LITER, MEQ/L MILLIFOUTVELENTO PER LITER, FT = FEET, MT = METERS, (M) = MEASURED, (E) = COTTMATED, (B) = REPORTED, TR = TOTAL RECOVERABLE, TOT = TOTAL;

GW NA SE WI ON PU AT OTHER

OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST CUIT DATE: 19-FER 02 BY: TO \*UNG
FROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 07 MAY 83

FERRENT MERVL (FOR PIPER PLOT)

CA MG NA K CL 904 MC03 C03
48.0 46.7 4.5 0.5 0.6 22.1 0.0 0.0

NOTE: In Commember with the East Refer to Lab Humber: Bigisis 1-9

WATER GHALTTY ANALYSIS LAP NO. 0101514

STATE MONTANA COUNTY CASCADE SUFF LUCATION DON 3F DW ARFO MUMB SITE OF DO STATION IB 4/26581111 1801 SAMPLE SOURCE STREAM LATITUDE LONGITHUE 47026'58'N 111017'38'W CO ARPE O UTH COORDINATES N ร้อมกามพิธิธา ธละล้า TOPOSRAPHIC MAR 1 ALLS 7 1 GEOLOGIC SOURCE DRAINAGE BASIN ż LAND SUBFACE ALTITUDE

WATER CLOW RATE
FILDW MEAS METHOD WETE

STACE GAGE 3:3: \*BOTILE NUMBER OF OF MRHG\*JJD GFIB 13. BATE SAMPLED 26-A TIME SAMPLED 16:0 LAR + ANALYST MRMG DATE ANALYZED SAMPLE HANDLING 4220 26 - AUG 81 STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM WIDTH 16:00 HOURS LOW FLOW HRHG\*FNA .1 FT (H) 10. METHOD SAMPLED GRAD

WATER USE UNUSED

SAMELING SITE SAND COULEE CR#BRIBGE AT MISSOURI RIVER FB DRAINAGE BASIN MISSOURI RIVER RETWEEN MARIAS RIVER AND LITTLE PRICELY PE

	#G/I	MEQ/L			8671	HEQZL
CALCIUM (CA)	181.	2.03	RICARRONATE	(R003)	. 0	
MAGNESTUM (HG)	O6.3	7.10	CARBONATE	(0.03)	. 0	
SOMIUM (NA)	38.8	1.69	CHIORIDE	(CL)	72.6	0.64
FOTASSIUH (K)	7.5	0.20	SULFATE	(004)	1450.	31.02
IRON (FE)	15.7	0.84	NITRATE	(AS N)	. 7.4	0.05
MANGANESE (HN)	1.79	0.07	ELUORIDE	(F)	3.41	0.18
SILICA (SIG2)	27.1		PROGREATS TOT	(AS P)		
TOTAL CATIONS		18.93	TOTAL	ANTOUS		31.87

STANDARD DEVIATION OF ANIOH CATION BALANCE (SIGNA)

LABORATORY PH 3.27 TOTAL HARDNESS AS CACO3 807.17
FIELD WATER TEMPERATURE 13.2 C TOTAL ALKALINITY AS CACO3
CALCULATED DISSOLVED SOLIDS SONIUM ADSORPTION RATIO 0.57
SUM OF DISS. CONSTITUENT RYZNAR STABILITY INDEX
LAB SPEC.COND.(MICROMHOS/CM) 2348. LANGLIER SATURATION INDEX

PARAMETER TEMPERATURE, AIR (C) FIFLE PU NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L AS PR) STRONTIUM, DISS (MG/L AS TI) VANABIUM, DISS (MG/L AS V) ZINC, DISS (MG/L AS ZN)	VALUE 25. 0 2.71 1.39 1.04 .79 .033 .004	PARAMETER (NEUCTVY, FITLE HICROHHOS ALUHINUH, BISS (HG/L-AL) SILVER, BISS (HG/L-AS AG) BORON , DISS (HG/L-AS AG) CADHIUH, DISS (HG/L-AS CD) CHROMIUH, DISS (HG/L-AS CU) LITHIUM, DISS (HG/L-AS LI)	VALUE 3151. 117. .002 .12 .021 .032 .13
ZINC+DISS (MGZL AS ZN)	5.48	LITHIUM, NISS (MG/L AS LI)	.18
ZIRCONIUM DIS(MGZL AS ZR	<.003	MOLYRDENUM, NISS (MG/L-MO)	.06
SELENTUM+ DISS (UGZL+SE)	.4	ACINITY, TOT (MG/L-CACO3)	810.

REHARNS: WATER IS TURBID, HURKY, ALGAE-RICH \* LARGE FLOCCULENIS OF ORANGE CE-HYDROXIDE PRECIPITATE \* RANKS % RED RICH IN FE-HYDROXIDE HUD DEPOSITED AFTER HAY FLOOD \* HIGH WATER @ 5.4 ABOVE CHANNEL \* LAB: H: 18.31 MG/L GIVES 34.21 MFQ CATIONS GIVES 3.7 SIGNA

EXPLANATION: MG/L = MILLIGRAMS PER LITER, MG/L = MICROGRAMS PER LITER, MEG/L MILLIEQUIVELENTS PER LITER. FI = FECT, MI = METERS. (M) = MEASURED, (F) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. FOT = TOTAL.

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OTHER AVAILARIE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 19-SER 02 BY: TP=\*JNS
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27 MAY 83

PERCENT MEQ/L (FOR PIPER PLOT) CA MG NA K CL SO4 HCO3 CO3 50.1 32.4 2.4 1.1 2.0 28.0 0.0 0.0

HOTE: IN CORRESPONDENCE, PLEASE REFER TO LAR NUMBER: 8101516 9-10

HONTANA BUREAU OF HINES AND GEOLOGY BUTTE, HONTANA 59701 (406)496-4101

WATER QUALITY ANALYSIS LAB NO. 8181514

STREAM WIDTH

MONTANA COUNTY CASCADE SITE LOCATION 15N 5E 19 AACD STATE 47D23'20'N LATITUDE-LONGITUDE #### STEE COCHILON 19N SE 19 AACD MRHG SITE CF-12

ALLS 7 1 STATION ID 472320111062401

\* SAMPLE SOURCE STREAM
LAND SURFACE ALTITUDE 3464. FT < 1
WATER FLOW RATE 360,0 GPH
FLOW HEAS METHOD ESTIMATED
STAFF GAGE
STEERN STAFF UTH COORDINATES Г SOUTHEAST GREAT FALLS 7 1 TOPOGRAPHIC MAP GEOLOGIC SOURCE ± DRAINAGE RASIN AGENCY + SAMPLER BOTTLE NUMBER DATE SAMPLED EER < 10 HBHG\*JLS CF -12 27-AUG-81 12:00 HOURS DATE SAMPLED 12:0 LAR & ANALYST MRMG DATE ANALYSED SAMPLE HANDLING 4220 STREAM STAGE DEPTH TO SAMPLE TOTAL DEPTH OF WATER **HBHG\*FNA** 

NATER USE UNUSED

METHOR SAMPLED GRAD

SAMPLING SITE COTTONWOOD CREEK \* AT CENTERVILLE SCHOOL DRAINAGE BASIN HISSOURI RIVER BETWEEN HARIAS RIVER AND LITTLE PRICKLY F

CALCIUM (CA) MAGNESIUM (MG) SOBIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) STLICA (S102)	60.1 4.94 C 15.8 0.69 C 5.1 0.13 S 9.60 0.52 N .93 0.03 F	ICARBONATE (HCOJ) ARBONATE (COJ) HLORIDE (CL) ULFATE (SO4) ITRATE (AS N) LUORIDE (F)	HG/I .0 .0 6.7 891. 0.04 1.44	0.17 18.55 0.15 0.08
TOTAL CATIONS	13.85	TOTAL ANIONS		18.76
STANDARD DEVIAT	ION OF ANION-CATIO	N BALANCE (SIGHA)		
LABOR FIELD WATER TEM ALCULATED DISSELVE		TOTAL HARDNESS AS TOTAL ALKALINITY AS SODIUM ADSORPTION	CACG3	24.42 0.28

CA SUM OF DISS. CONSTITUENT RYZNAR STABILLTY INDEX SPEC.COND. (HICROHHOSZCH) LANGLIER SATURATION INDEX 1598. LAF:

PARAMETER	VALUE	PARAHETER	VALUE
TEMPERATURE, AIR (C)	22.	CNDUCTVY+FIELD HICROHHOS	1233.
FISUD OH	3.34	ALUHINUH, DISS (HG/L-AL)	43.3
NICKEL/DISS (MG/L AS NI)	• ? 2	SILVER•DISS (HG/L AS AG)	,002
LEAD, DISS (MG/L AS PB)	<.04	BORON →DISS (MG/L AS B)	.04
STRONTIUH+DISS (HS/L-SR)	· 42	CADHIUH, DISS(MG/L AS CD)	.015
TITANIUH DIS(MG/L AS TI)	• ଡ଼ସର	CHROMIUM, DISS (MG/L/CR)	.014
VANADIUH,DTSS(HG/L AS V)	.005	COPPER-DISS (HG/L AS CU)	.030
ZINC·DISS (MG/L AS ZN)_	-3.04	LITHIUM, DISS(MG/L AS LI)	.087
ZIRCONIUH DISCHG/L AS ZR	.003	MOLYBRENUM.RISS(MG/L-MO)	02
SELENTUM, DISS (UG/L-SE)	3.	ACIBITY+TOT(HG/L-CACD3)	340.

REHARKS: FLOW BY SUBTRACTION FROM CF-03 WEIR (DF-01=CA.15 GPH) \*

HORE COMPACT FLOC-USED 2 FILTERS LAB: H+ 6.90 MG/L GIVES 20.1 MER CATIONS GIVES -2.9 SIGMA

EXPLANATION: HG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, MEQ/L HILLIEQUIVELENTS PER LITER, FT = FEET, MT = METERS. (M) = MEASURED, (F) = ESTIMATED, (R) = REPORTED, TR = TOTAL RECOVERABLE. TOT = FOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

cost: PROJECT: LAST FRIT DATE: 19 FEB-02 F1730F V2 TP \*JKS BY: PROCESSING PROGRAM: E 1730E (11/3/81) PRINTED: 27"HAY-83

> PERCENT MEGAL CA MG NA 56.7 37.2 5.2 (FOR PIPER PLOT) K OL SO4 HCO3 , k 003 1.0 99.0 0.0 1.0

TH CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: B101514  $_{
m D=11}$ NOTE:

#### WATER QUALITY ANALYSIS TAE NO. 8181515

SIAIC MONTANA COUNTY CASCADE STIF LOCATION 18H 5F MRHG SITE CE 16 LATTIDDE -LONGITUDE UIM COORDINATES 47515123\*# 1111107/05\*# 7#CCAA THE SITE OF 16
STATION IN 471923111090501
\* SAMPLE SOURCE STREAM
LAND SURFACE ALTITUDE 3855. LT 1
WATER FLOW RATE 350.0 GPM
FLOW MEGS HELHOD WEIR 1/2/ STOCKETT TOPOGRAPHIC HAP EDLOGIC SOURCE DRAINAGE BASIN GEOLOGIC 1.0 AGENCY & SAMPLER BOTTLE NUMBER HRMG\*JLS OF: 16 28 AUG 81 STAFF DATE SAMPLED GAGE TIME SAMPLED STREAM STAGE 18:00 HOURS LAR F ANALYST MRNG DATE ANALYZED 29-SI SAMPLE HANDLING 4000 DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM WIDTH #RNG≭FNA 29:SFP 81 0.6 FT (H) HETHOD SAMPLED GRAD

WATER USC UNUSED

SAMPLING SITE COTTONWOOD CREEK \* BELOW BILL SHIRLEY FARM
DRAINAGE BASIN HISSOURI RIVER RETWEEN MARIAS RIVER AND LITTLE PRICELY P

CALCIUM (CA) MAGNESIUM (MG)	MG/I 56.7 34.1		BICARBONATE CARBONATE	(HC03)	MG/1 285. 0.	MEQ/L 4.67
SOFIUM (NA) SOFIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILIGA (SIG2)	34.1 11.4 3.1 .30 .032 8.4	0.50 0.08 0.07 0.00	CHLORINE	(CL) (SD4) (AS N) (F)	3.7 49.1 5.33 .57	0.10 1.02 0.38 0.03
TOTAL CATIONS		6.23	TOTAL	antons		6.21
STANDARD DEVIAT	TON OF AN	ION-CATI	ON BALANCE	(SIGHA)	0.10	
LABOR FIELD WATER TEM CALCULATED DISSOLVE SUM OF DISS. CON LAB SPEC.COND.(MICRO	D SOLIDS ISTITUENT ORHOSZCH)	21.4 313.13 457.73 417.6	RYZNAR S LANGL TER SA	INITY AS SORPTION TABLLITY TURATION	CACO3 DEATION INDEX	81.94 33.75 0.30 3.50 0.80
PARAMETER TEMPERATURE, AIR (C) ALUMINUM, BISS (MG/L-SILVER,DISS (MG/L-AS-BORON,DISS (MG/L-AS-CADMIUM,DISS (MG/L-AS-CADMIUM,DISS (MG/L-AS-CAPPER,DISS (MG/L-AS-LITHIUM,DISS (MG/L-AS-MOLYBDENUM,DISS (MG/L-SELENIUM,TR (UG/L-AS-	AL) AG) B) CD) CD) CU) LI)	ALUE 0.31 0.002 0.002 0.002 0.002 0.003 0.003	PARAM CNDUCTVY,FIF NICKEL,DISS LEAD,DISS CSTRONTIUM,DIS TITANIUM DIS VANADIUM,DIS ZINC,BISS ZINC,BISS ZIRCONIUM DI SELENIUM, DI	LD MICRON (MG/L AS MG/L AS F SS (MG/L (MG/L AS S(MG/L AS MG/L AS S(MG/L AS	1HOS 5 NI) NE) -SR) -II) S V) (N) S ZR	CALUE CO 024 CO 027 CO 0013 CO 0003 CO 0003

REHARKS: WATER IS MURKY, SOME FE-HYDROXIDE PRECIPITATES\*MUDDY COLOR\*REQUIRED : FILTERS\*RELOW CONF OF STREAM THRU SHIRLEY RANCH AND ACID STREAM DRAIL ING RESERVOIR\*FH HIGHLY UNSTABLE \* ELECTRODE POISONS\*CROSS REF 81018

EXPLANATION: MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEG/L MILLIEQUIVELENTS PER LITER. FT = FEET, M1 = MLIFRS. (M) = MEASURED, (E) = ESTIMATED, ( $\hat{\mathbf{x}}$ ) = REPORTED. TR = TOTAL RECOVERABLE. TOT = IOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

COST: PROJECT: LAST EDIT DATE: 25-NOV-81 RY: TF: \*TF 27 MAY-83 PROCESSING PROGRAM: F1730F V2 (11/3/81) PRINTEDA

> PERCENT HEAZL (FOR PIPER PLOT) CA MG NA C1. S04 HE03 0.03 木 1.3 17.5 30.5

IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER: 8101515  $_{
m D-12}$ NOTE:

WATER QUALITY ANALYSIS LAB NO. 8101517

STATE HONTANA COUNTY CASCADE SITE LOCATION 19N SE 19\*AACD (
HBHG SITE DF-01
STATION ID 472321111082101
SAMPLE SOURCE STREAM 47D23'21"N 111D08'21"₩ LATITUDE - LONGITUDE HBHG SITE STATION ID SAHPLE SOURCE UTH COORDINATES SOUTHEAST GREAT FALLS 7 1 TOPOGRAPHIC HAP \* SAMPLE SOURCE STREAM SURFACE ALTITUDE 3464.
WATER FLOW RATE 15.
FLOW HEAS HETHOD ESTIMATED GEOLOGIC SOURCE DRAINAGE BASIN \* FT BASIN LAND NOTTLE NUMBER
DATE SAMPLED
TIME SAMPLED HBHG\*JLS GPM AGENCY DF - 01 STAFF 27-AUG-81 GAGE STREAK STAGE 10:30 HOURS LAB + ANALYST MBMG\*FNA
DATE ANALYZED 12-0CT-81
SAMPLE HANDLING 4220 DEPTH TO SAMPLE TOTAL DEPTH OF WATER STREAM WIDTH

WATER USE UNUSED

METHOD SAMPLED GRAD

SAMPLING SITE SAND COULEE CR\*UPSTREAM FROM COTTONWOOD CR DRAINAGE BASIN MISSOURI RIVER BETWEEN MARIAS RIVER AND LITTLE PRICKLY PH

CALCIUM (CA) MAGNESIUM (MG) SODIUM (NA) POTASSIUM (K) IRON (FE) MANGANESE (MN) SILICA (SIO2)	MG/I. 33.2 30. 8. 3.4 .076 .022 4.0	2.47 CA 0.35 CH 0.05 SU 0.00 NI 0.00 FL	CARBONATE RBONATE LORIDE LFATE TRATE UORIDE OSPHATS TOT	(HCO3) (CO3) (CL) (SO4) (AS N) (F) (AS P)	HG/L 155.2 0. 2.8 94. .05 .51	HEQ/L 2.54 0.08 1.96 0.00 0.03
TOTAL CATIONS		4.56	TOTAL.	ANIONS		4.61
STANDARD DEVIAT	TION OF AN	ION-CATION	BALANCE	(SIGHA)	0 - 26	

LABORATORY PH 7.96 TOTAL HARDNESS AS CACO3 206.38
FIELD WATER TEMPERATURE 25.0 C TOTAL ALKALINITY AS CACO3 127.29
CALCULATED DISSOLVED SOLIDS 252.51 SODIUM ADSORPTION RATIO 0.24
SUM OF DISS. CONSTITUENT 331.26 RYZNAR STABILITY INDEX 7.79
LAB SPEC.COND.(MICROMHOS/CH) 412.0 LANGLIER SATURATION INDEX 0.09

VALUE PARAMETER VALUE PARAMETER 22.0 C 8.41 CNDUCTVY, FIELD HICROHHOS ALUHINUM, DISS (MG/L-AL) 370. -28 <.002 TEMPERATURE, AIR (C) FIELD PH NICKEL, DISS (MG/L AS NI) LEAD, DISS (MG/L AS PB) CIRCUTTUM, DISS (MG/L SR) SILVER, DISS (HG/L AS AG) BORON, DISS (HG/L AS B) CADHIUH, DISS (HG/L AS CD) CHROHIUH, DISS (HG/L-CR) .02 LEAD, DISS (MG/L AS PB)
STRONTIUM, DISS (MG/L SR)
TITANIUM DIS(MG/L AS TI) <.02 < . 04 . รีร่ <.002 <.001 <.002 <.00î (MG/L AS CU) S(MG/L AS LI) .002 AS COPPER, DISS VANADIUH, DISS (MG/L V) (HG/L AS ZN) .007 ZINC, DISS .006 LITHIUM, DISS (MG/L ZĪRCONĪŬM DIS(HG/L AS ZR .003 HOLYBDENUH, DISS (HG/L-MO) <.02 SELENIUM, DISS (UG/L-SE) SELENIUH, TR (UG/L AS

REHARKS: USED & FILTERS - 80-100 HL/FILTER \* GEL-LIKE PPT. ON FILTER (SDAP?) \* CROSS REF. 8101839 \*

EXPLANATION: MG/L = HILLIGRAMS PER LITER, UG/L = HICROGRAMS PER LITER, MEQ/L HILLIEQUIVELENTS PER LITER. FT = FEET, MT = METERS. (M) = MEASURED, (E) = ESTIMATED, (R) = REPORTED. TR = TOTAL RECOVERABLE. TOT = TOTAL.

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OTHER AVAILABLE DATA OTHER FILE NUMBERS:

PROJECT: COST:
LAST EDIT DATE: 25-NOV-81 BY: TP \*TP
PROCESSING PROGRAM: F1730P V2 (11/3/81) PRINTED: 27-MAY-83

PERCENT HER/L (FOR PIPER PLOT)
CA HG NA K CL SO4 HC03 CO3
36.3 54.1 7.6 1.7 1.7 42.7 55.5 0.0

NOTE: IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER:  $8101517 - _{D-13}$  Reads

# D-7

# DAILY DISCHARGE DATA AND STREAMFLOW HYDROGRAPHS

# Stations:

AF01 CF02

CF03

- Control
0.0000000000000000000000000000000000000
THE REAL PROPERTY.
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- 11

WATER YEAR FROM SEPT 1980 TO OCT 1 1981 T 19N R 04E SEC 12 DODC LAT 0 0 0 K LONG MEAN DISCHARGE, CFS EEB APR DAY CCT NOV DEC MAR dAY JUN 211 AUG SEF JAN 7.504 1.635 5.067 0.701 0.347 \*\*\*\*\*\*\*\*\*\* 0.000 0.000 0.000 0.000 3.433 2.442 2.015 0.293 0.002 0.000 5.391 0.673 \*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\* 0.000 0.000 6.003 1.668 \*\*\*\*\*\*\*\* \*\*\*\*\*\*\* 0.000 0.004 0.000 0.000 3,455 1,523 5.041 0.351 0.003 0.000 1.890 1.523 0.325 0.000 \*\*\*\*\*\*\*\* \*\*\*\*\*\*\* 0.137 5.214 3.100 0.663 1.720 111111111 111111111 0.000 0.004 0.000 0.031 1.801 5.020 2,843 0.618 4.935 2.574 \*\*\*\*\*\*\* 0.099 0.000 0.017 0.000 0.000 1.660 1.989 0.610 0.312 0.273 \*\*\*\*\*\*\*\* 0.109 0.000 0.015 0.000 0.000 1.562 2.010 4.688 2.175 0.606 1.252 0.000 0.000 4.805 4.607 0.274 8 11111111 0.101 0.000 0.017 1,500 0.618 0.000 0.000 0.000 1.172 1.969 4.235 2.104 0.283 Q 111111111 0.071 0.043 0.610 0.000 1.417 2.067 0.583 0.283 0.000 1.791 4.688 10 \*\*\*\*\*\*\* 0.064 0.055 0.006 4.527 0.274 0.008 0.000 0.000 1.326 1.905 1.577 0.575 111111111 0.049 0,190 11 2.400 0.000 1.276 5.031 1.577 0.568 0.264 0.028 0.051 0.011 0.000 12 \*\*\*\*\*\*\* 0.549 13 0.029 0.000 1,184 4.449 1.994 9.264 \*\*\*\*\*\*\*\* 0.004 0.009 0.018 6.958 0.254 0.000 2.067 1.163 1.660 0.534 \*\*\*\*\*\*\*\* 0.000 0.080 0.008 0.378 14 3.879 0.000 0.005 0.000 1.206 0.955 0.520 111111111 0.214 0.344 0.254 3.198 1.229 7.760 0.949 \*\*\*\*\*\*\* 0.001 0.034 0.000 0.270 0.000 0.449 0.000 0.002 0.059 0.000 1.326 3,235 3.078 0.333 0.427 0.245 22222222 0.010 17 2.793 4.294 0.236 0.236 \*\*\*\*\*\*\*\* 0.009 0.000 0.121 0.012 0.000 1.352 6.579 1.009 0.444 18 0.000 0.136 0.000 1.406 6.414 0.952 0.448 19 \*\*\*\*\*\*\* 0.007 0.000 0.000 6.515 4.527 0.911 0.227 0.004 0.000 0.000 1.434 0.461 20 \*\*\*\*\*\*\* 0.064 0,000 0.899 0.037 0.000 0.027 0.000 1,500 9.557 5.084 0.458 0.236 21 \*\*\*\*\*\*\*\* 0.227 0.210 0.210 0.342 22 23 0.000 0.000 1.685 10.026 7.337 0.896 0.409 \*\*\*\*\*\*\*\* 0.000 0.000 0.007 7.975 5.020 1.530 0.888 0.394 \*\*\*\*\*\*\* 0.001 0.000 0.000 0,000 0.053 0.000 0.000 0.000 0.053 1.554 7.701 4.738 0.880 0.400 \*\*\*\*\*\*\*\* 0.033 0.324 0.000 0.000 0.460 7,434 4.607 0.883 0.431 0.000 \*\*\*\*\*\*\*\* 1.585 1.554 26 27 0.893 7.518 4.708 0.880 0.431 0.231 \*\*\*\*\*\*\*\* 0.011 0.318 0.000 0.000 1.835 0.835 0.389 0.199 0.000 5.489 4.419 0.086 0.000 \*\*\*\*\*\*\*\* 0.050 0.195 0.000 6.338 4.769 0.813 0.336 28 \*\*\*\*\*\*\* 0.049 0.002 0.000 1.764 1.523 0.000 1.685 0.000 2.475 5.923 4.449 0.795 0.336 0.151 29 0.024 0.003 \*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\* 0.003 0.000 0.000 0.000 4.713 1.651 5.734 3.699 0.749 0.451 0.314 30 111111111 0.000 0.000 0.000 8.450 0.000 0.000 0.699 0.000 0.000 1.090 15.781 TOTAL ECCEPTED CONTRACTOR 1.385 0.507 20,892 56.553 151.753 142.171 45.706 7,854 4.075 1.474 HEAN 11111111 11111111 0.045 0.016 0.039 0.674 1.835 4.739 0.509 0.762 0.324 0.347 HAX 0.000 0.109 0.136 0.378 €.450 7.504 10.026 7.337 3.433 0.701 2.773 0.151 1.122 1.523 0.679 0.336 MIN 11171111 0.000 0.000 0.000 0.000 0.000 AC-FT 11111111 11111111 2.747 1.006 2,163 41.439 112.172 300.597 281.993 90.657 31.302 15.578

STRAIGHT CREEK NEAR SAND COULEE, MT.

' STATION AF0181

## DISCHARGE, CFS ##

1,43 10,03 8,57 4,30 2,86

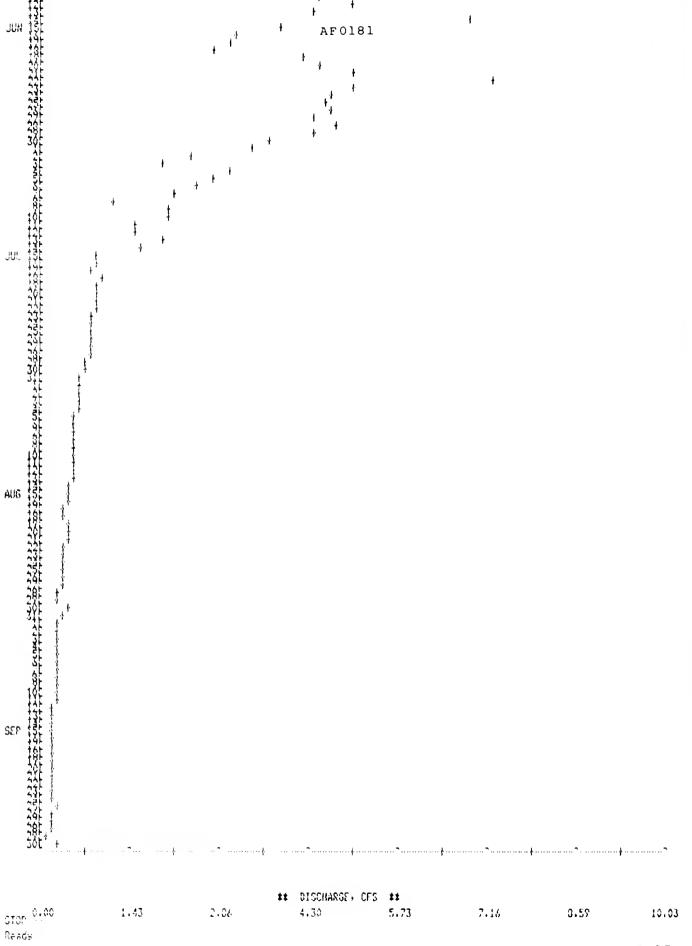
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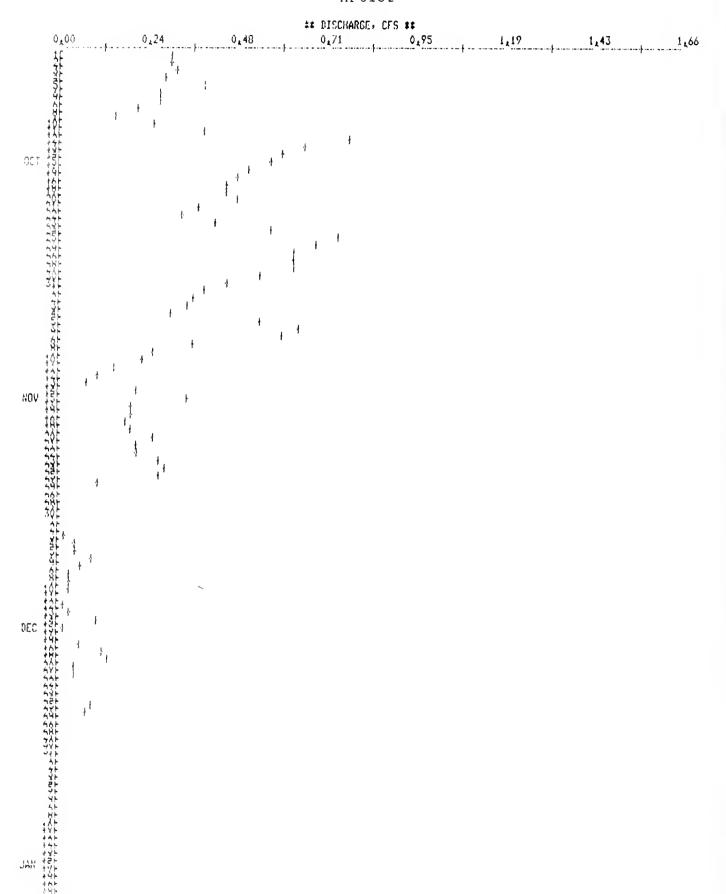
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	ION AF0182 YEAR FROM	2 SEPT 1981		CREEK NEAR 1982		EE, MT. R 04E SEC	12 PCDC	LA	11 0 0 0	) N LONG	0 0 0 4
DAY	OCT	NOV	DEC	JAN	LEB	MEAN DISC MAR	CHARGE, CFS 1	l nay	אטע	JUI	AUG SEF
1 2 3 4 5	0.304 0.304 0.314 0.293 0.389	0.374 0.359 0.347 0.306 0.549	0.000 0.000 0.026 0.047 0.058	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.325 0.119 0.048 0.110 0.148	0.062 <b>:</b> 0.073 <b>:</b> 0.083 <b>:</b> 0.094 0.012	0.038\$ 0.040\$ 0.042\$ 0.044\$ 0.046\$	0.0971 0.0991 0.1011 0.1031 0.1051	0.158: :::::::::::::::::::::::::::::::::::
6 7 8 9	0.274 0.269 0.210 0.155 0.259	0.641 0.597 0.358 0.254 0.228	0.095 0.072 0.032 0.033 0.031	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.008	0.263 0.003 0.166 0.316 0.736	0.162 0.105 0.070 0.130 0.109	0.046# 0.050# 0.052# 0.054# 0.056#	0.1072 0.1072 0.1112 0.1132 0.1152	0.1683 SETTETTE 0.1703 SETTETTE 0.1723 SETTETTE 0.1743 SETTETTE 0.1763 SETTETTE
11 12 13 14 15	0.391 0.781 0.667 0.602 0.572	0.162 0.116 0.087 0.210 0.344	0.014 0.017 0.030 0.108 0.024	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.092 0.106 0.127 0.104 0.038	1.564 0.795 0.809 0.587 0.476	0.016 0.004 0.001 0.003 0.005	0.0582 0.0602 0.0623 0.0648 0.0663	0.117# 0.119# 0.121# 0.123# 0.125#	0.170# ###################################
16 17 18 19 20	0.513 0.485 0.458 0.456 0.490	0.194 0.202 0.186 0.202 0.253	0.010 0.073 0.124 0.137 0.056	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.008 0.009 0.003 0.000 0.099	0.657 0.328 0.277 0.321 0.431	0.007\$ 0.007\$ 0.011\$ 0.013\$ 0.015\$	0.068# 0.070# 0.072# 0.074# 0.076#	0.127# 0.129# 0.131# 0.133# 0.135#	0.188# ######## 0.190# ######## 0.152# ####### 0.174 #######
21 22 23 24 25	0.373 0.330 0.419 0.573 0.756	0.214 0.219 0.269 0.283 0.282	0.054 0.010 0.013 0.001 0.091	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.054 0.260 0.290 0.136 0.086	0.261 0.069 0.033 0.034\$ 0.035\$	0.017# 0.019# 0.020# 0.022# 0.024#	0.078# 0.080# 0.087# 0.084# 0.086#	0.139 <b>t</b> : 0.141 <b>t</b> 0.143 <b>t</b> :	
26 27 28 29 30 31	0.684 0.634 0.634 0.634 0.542 0.458	0.119 0.010 0.000 0.000 0.000 0.000	0.079 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.150 0.326 0.723 0.732 0.354 0.293	0.036# 0.038# 0.039# 0.040 0.051# 0.000	0.026\$ 0.028\$ 0.030\$ 0.032\$ 0.034\$ 0.036\$	0.087# 0.089# 0.091# 0.093# 0.095# 0.000	0.149# 0.151# 0.153# 0.154#	######################################
TOTAL MEAN MAX MIN AC-FT	14.223 0.459 0.781 0.155 28.211	7.386 0.246 0.641 0.000 14.650	1.235 0.040 0.137 0.000 2.450	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	3.999 0.129 0.732 0.000 7.932	9.213 0.307 1.664 0.003 18.274	1.271 0.041 0.162 0.001 2.521	2.004 0.067 0.095 0.038 3.975	0.127 0.156 0.097	0.194 0.000 0.158 ************************************

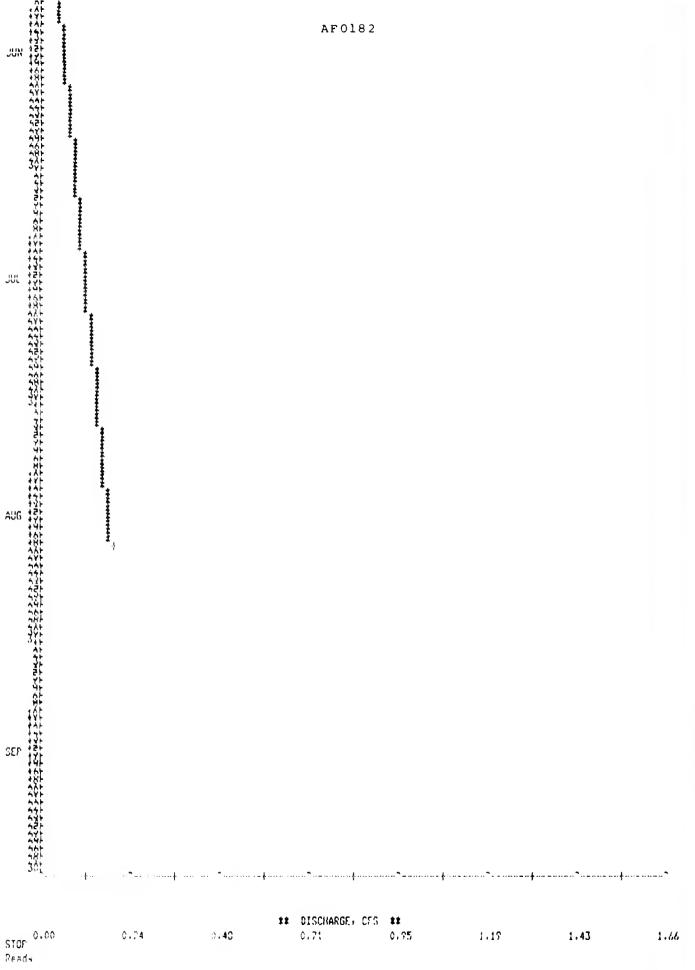
Record accuracy affected by siltation and corrosion of weir plate, worsening throughout year. Interpolated value.



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APR



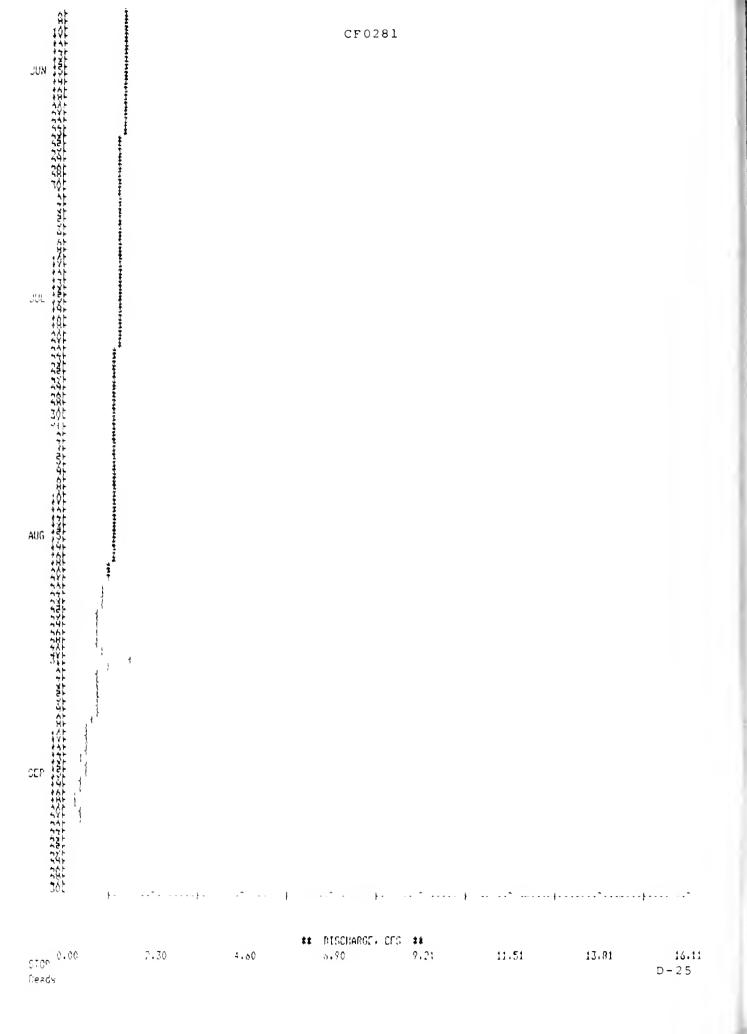
' STA'	TION CF028. YEAR FROM	1 SEPT 1980	SAND COULER TO OCT 1 19	E CREEK NEA			C 19 AACA	L	AT 0 0 (	ON LONG	0 0	0 <b>W</b>
••••							CHARGE, CFS	3				
DAY	OCT	NOV	DEC	JAN	FEB	HAR	APR	MAY	JUN	JLIL	AUG	132
1		*******	0.000	0.000	0.000	0.000	14.818	1.857	1.698	1.5448	1.385	1.195
2		********	0.000	0.000	0.000	0.000	14.176		2 1.6931	1.539	1:380	0.959
3		111111111	0.000	0.000	0.000	0.000	13.186 11.286	1.8462 1.8412	1.687 <b>*</b> 1.682 <b>*</b>	1.534 <b>#</b> 1.528 <b>#</b>	1.3751	0.929 0.929
5		111111111	0.000	0.000	0.000	0.000	11.014	1.336	1.6778	1.523	1.3648	0.942
6	********	0.000	0.000	0.000	0.000	0.000	14.050	1.831\$	1.672	1.518#	1,359\$	0.955
7	*******	0.000	0.000	0.000	0.000	0.000	10.037	1.826	1.5678	1.5132	1.354	0.942
8	********	0.000	0.000	0.000	0.000	0.000	9.070 7.773	1.821 <b>\$</b> 1.316 <b>\$</b>	1.662 <b>*</b> 1.657 <b>*</b>	1.508 <b></b> 1.503	1.349 <b>\$</b> 1.344 <b>\$</b>	0.828 0.714
10	********	0.000	0.000	0.000	0.000	0.000	6.760	1.811	1.652	1.498\$	1.339	
11	*******	0.000	0.000	0.000	0.000	0.000	6.669	1.805#	1.6468	1.492	1.333\$	0.651
12	*****	0.000	0.000	0.000	0.000	0.000	6.376	1.800	1.641*	1.487	1.328	0.599
13	111111111	0.000	0.000	0.000	0.000	0,000	5.572 5.138	1.795 <b></b> 1.790	1.636 <b>*</b> 1.631 <b>*</b>	1.482* 1.477*	1.323 <b></b> 1.318	0.572 0.595
14 15	1111111111	0.000	0.000	0.000	0.000	0.000	5.009	1.785\$	1.526	1.4728	1.313	0.579
16	*******	0.000	0.000	0.000	0.000	0.000	4.657	1.780\$	1.621#	1.467\$	1.308\$	0.549
17	12112111	0.000	0.000	0.000	0.000	0.000	4.410	1.775	1.616#	1.4528	1.3031	0.497
18	******	0.000	0.000	0.000	0.000	0.000	3.917	1.770	1.610	1,457	1,298 <b>#</b> 1,292 <b>#</b>	0.422 0.391
19 20	*******	0.000	0.000	0.000	0.000	0.000	3.623 3.750	1.764 <b>\$</b> 1.759 <b>\$</b>	1.600#	1.4512	1,287	0.448
21	111111111	0.000	0.000	0.000	0.000	0.000	4.607	1.754#	1.595#	1,441	1.782	0.478
22	*******	0.000	0.000	0.000	0.000	0.000	3.361	1.749	1,590	1.4368	1.122	********
23	*******	0.000	0.000	0.000	0.000	0.000	2.883	1.7442	1.585#	1.4318	1.031	1111111111
24 25	********	0.000	0.000	0.000	0.000	0.000	2.658 2.523	1.739 <b>*</b> 1.734 <b>*</b>	1.580# 1.575#	1.426	0.984	*******
26	********	0.000	0.000	0.000	0.000	0.000	2.672	1.728#	1.569#	1.416\$	0.969	********
27	********	0.000	0.000	0.000	0.000	2.282	2.773	1.723	1.554	1.4103	0.969	*******
28	*******	0.000	0.000	0.000	0.000	1.879	2,424 2,358	1.718 <b>*</b> 1.713 <b>*</b>	1.559 <b>‡</b> 1.554 <b>‡</b>	1.405# 1.400#	0,955 0,926	********
29 30	1111111111	0.000 0.000	0.000	0.000	0.000	7 <b>.9</b> 51 16.109		1.708	1.549\$	1.395#	1.040	111111111
31	*******	0.000	8.888	0.000	8.888	13.896	0.000	1.703	0.000	1.390	1.824	0.000
	*******	*******	0.000	0.000	0.000	42.117	189.624	55.173	48.699	45.472	38.840	********
HEAN	******	******	0.000	0.000	0.000	1.359	6.321	1.780	1.623	1.467	1.253	11111111
MAX	0.000	0.000	0.000	0.000	0.000	16.109	14.818 2.056	1.857 1.703	1.698 1.549	1.544 1.390	1.824	1.195 0.391
MIN AC-FT	11111111	******	0.000	0.000	0.000	83.539	376.114	109.434	96.594	50.193	77.037	*******

Weir capacity exceeded
 Weir washout, no record from 5-2 through 8-20

Interpolated value

## DISCHARGE, CFS ## OCT NOV DEC JAN

D-23



	TION CFO282 YEAR FROM:		SAND COULEE TO OCT 1 19				L 19 MACA	1	LAI O v	ON LON	G (4 )	ه ن
							CHARGE, OF					
DAY	CCT	HOV	DEC	JAN	LLA	MAR	APR	ner	JUN	JÜI.	AUG	يار.
2 3	111111111	11111111		0.025# 0.022# 0.018#	0.0001 0.0001 0.0001	0.000 0.000 0.000	0.000\$	********	111111111 111111111 111111111	********	*******	*********
5	######################################	11111111	0.123	0.014	0.000	0.000	0.000	*******	**********	*******	*******	111111111
5.7. ε		********	0.119 <b>:</b> 0.116 <b>:</b> 0.112 <b>:</b>	0.007 <b></b> 0.004 <b></b> 0.000	0.000 0.000 0.000	0.000	0.0003	111111111	111111111111111111111111111111111111111	177117:11	111111111	:::::::::::::::::::::::::::::::::::::::
10		*******	0.108:	0.000	0.000	0.005	0.0001	111111111	111111111	*******	*******	*******
11 12 13	######################################	*******	0.1013 0.0988 0.0941	0.0001 0.0001 0.0001	0.000 0.000 0.000	0.000	15.995 1	*******	######## ######### ###################	*********	******	********
14 15	*********	*******	0.0908	0.0001	10.130 23.0521	0.000	1.770	********	\$3 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	********	trestere	********
16 17 18		*******	0.083 <b>8</b> 0.030 <b>2</b> 0.076 <b>8</b>	0,000 <b>\$</b> 0,000 <b>\$</b> 0,000 <b>\$</b>	17,8321 11,432 3,213	0.000 0.000 0.000	0.012	*******		111321311	*******	*******
17 20	*********	********	0.072 <b>1</b> 0.069 <b>1</b>	0.0001	3.466 1.195	0.000		*******	11111111	*******	*******	*******
21 22 23	*********	*******	0.065 <b>;</b> 0.061 <b>;</b> 0.058 <b>;</b>	0.0001 0.0001 0.0001	0.000	0.000	######################################	:::::::::	********	*******	*******	*******
24 25	*********	*******	0.054 <b>1</b> 0.051 <b>1</b>	0.000\$	0.000	0.000#	111111111	*******	*******	********	******	********
26 27 28	*********	********	0.047# 0.043# 0.040#	0.000\$	0.000 0.000 0.000	0.000#	212122222 22222222 22222222	*******	*******	*******	*******	*******
29 30 31	111111111111111111111111111111111111111	11111111	0.036# 0.033# 0.029#	0.0003 0.0008 0.0003	0.000	0.000	111111111 111111111	:::::::::	********	*******	111111111	244442234
TOTAL MEAN MAX		0.000	######## ######## 0.130	0.101 0.003 0.025	75.321 2.690 28.052	0.016	####### ####### 15.995	******** ******** 0.000	######################################	######################################	1111111 7111111 000,00	11111111
HIN	11111111	*****	0.029	0.000	0.000 149.397	0.000		11211211	*******	11111111	********	11141111

<sup>1)</sup> Weir capacity exceeded.

<sup>2)</sup> Weir washout 4-12, flow not measured accurately afterwards.

 <sup>\*</sup> Interpolated value.

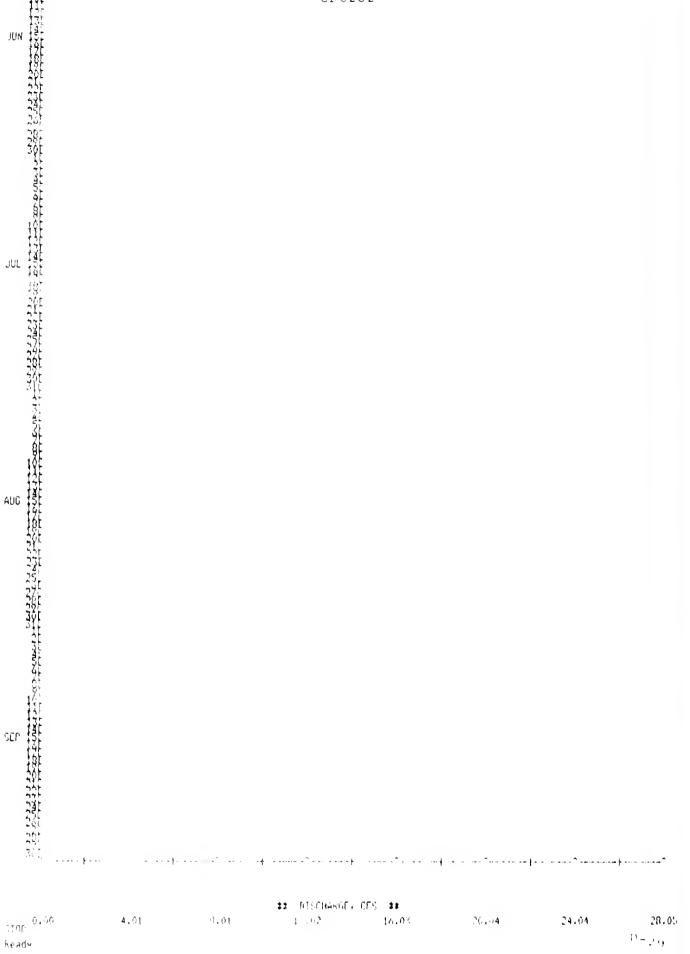
NOV DEC

F 1.8.

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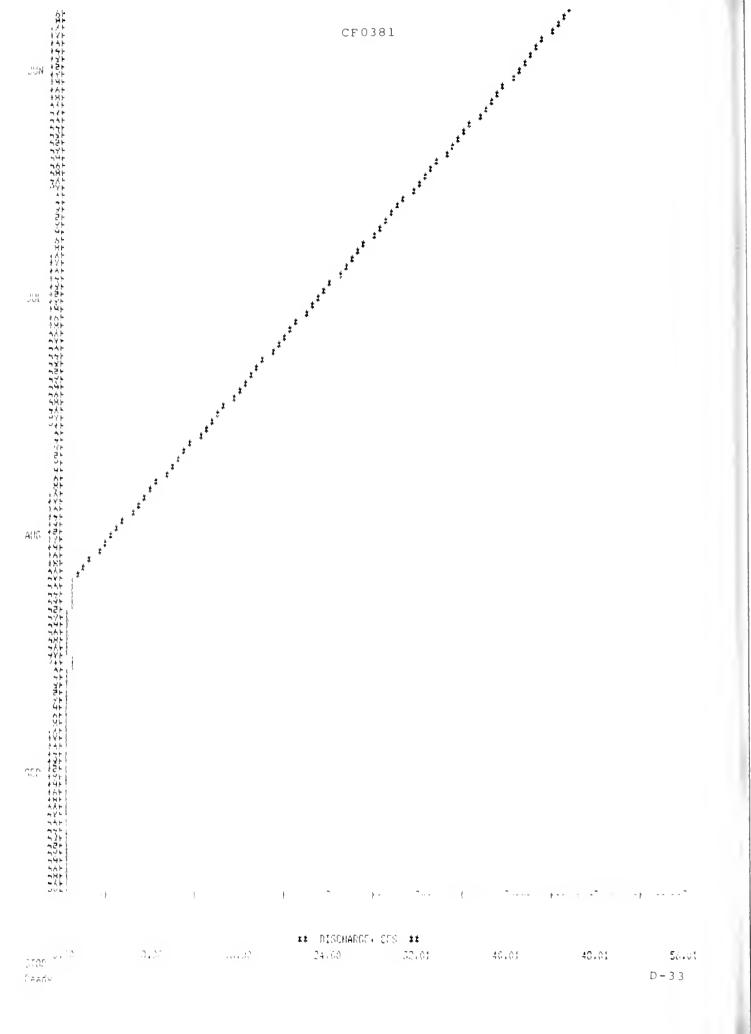
	TION CEUSEL TEAR FROM S		SAND COULER TO OCT 1 19			VILLER BI. F 04E SEC	13 AAAC	1	A(-):	o N (Shell		
DAT	100	NOV	200	JAN	FEL	mEAN DISC	HARGE, CES APR	; AA:	707	JUi	āl <sup>4</sup>	55)
~ cir2 <b>4</b> 00	######################################	0.219 0.216 0.202 0.202 0.202	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	35.146 31.561 25.344 22.812 22.3:3	2.4:3 2.357 2.353 2.191 2.191	00.4563 66.867 <b>\$</b> 48.3563 47.671 <b>\$</b> 17.075 <b>\$</b>	11.507# 60.991# 39.395# 39.000# 29.204#	7.10 : .5 4: 11.273: 12.733:	0.84 (.84 (.84 (.84
8 9 10	0.076 6.063 0.060 0.060 5.705	0.184 0.167 0.200 0.186 0.188	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	24.376 23.4123 29.4471 21.4833 20.5181	2.755 3.373 3.666 16.462 11.432	46.479\$ 45.884: 45.180\$ 44.590\$ 14.096\$	28.600: 28.013: 27.417: 26.321: 26.226:	0.1401 0.5411 0.541 .541	.674 2.132 3.75
11 12 13 14 15	0.150 0.150 0.142 0.124 0.343	0.204 0.241 0.093 0.043 0.035	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	10.554\$ 18.589\$ 17.625\$ 16.660\$ 15.696\$	11.194 15.344 16.804 14.430 15.344	43.5013 42.9058 42.3093 41.7148	25.620: 25.624: 24.43h; 23.847: 23.24/:	1.1632 6.5672 1.0721 6.3761 4.7803	0.587 0.587 0.587
100	0.527 0.903 0.740 0.451 0.415	0.058 0.057 0.066 0.055 0.017	0.000 0.000 0.000 0.000 0.000	0.000 0,000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	14./31# 13.787# 12.802# 11.338# 10.873#	32,346 51,139 51,139 51,139 51,139	40.522 <b>:</b> 39.027 <b>:</b> 39.731 <b>:</b> 38.735 <b>:</b> 38.140 <b>:</b>	22.651* 22.056* 23.460* 20.864* 20.269*	4 195: 2.5go: 2.793: 2.378: 1.803:	0.567 0.553 0.553 0.556 0.556
55 55 51	0.261 0.322 0.293 0.278 0.283	0.042 0.005 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	9.209# 8.244# 7.930# 7.015# 6.051#	54.010 55.415* 54.817* 54.223* 53.628*	1 76.948 <b>t</b> 1 36.352 <b>t</b> 1 75.757 <b>t</b>	19.6774 :9.0772 18.4812 !/.8364 17.2074	1.100 .184 1.14. 1.920 0.550	0.5% 0.587 0.587 0.587 0.855
26 27 28 29 30 31	0.310 0.330 0.290 0.764 0.245 0.236	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.124 11.095 2.483 20.754 37.557 32.681	5.0868 4.1278 3.157 3.435 2.606 0.000	53.0324 52.4353 51.8414 51.7453 50.6494 50.6533	74.5654 33.9703 33.7744 32.7784 32.1834 0.000	0.0941 16.0091 15.501 14.901 16.3171 13.7161	0.703 1.806 1.000 0.871 1.160	0.930 0.83_ 0.790 0.7.3 0.714 0.160
MEAN MAX MIN	300.0 0.000.0 0.00.0	2.884 9.094 0.241 0.000 5.721	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000	111,695 3,603 37,557 0,000 221,543	459.167 15.306 35.166 2.606 910.743	948.697 30.503 56.010 2.191 1881.717	4224.604 40.820 42.458 32.183 3428.768	702.192 22.651 7587 13.718 (392.777	159.887 5.150 11.157 11.130	017810 0.707 1.079 0.556 0.556

<sup>1)</sup> Weir capacity exceeded; washout occured 5-21, repaired 8-21.

<sup>\*</sup> Interpolated value.

## DISCHARGE, CFS ##

TO THE FORM TO SEE THE TOTAL THE TOT



STATE	CORUNG AGI 1 MORR RAR	TEFT :981	SARE COULCE TO OCT 1 19	CREEN HEA			is man	1	* P 1	1 # 1.5h	
DAY AMI	001	9127121 1713 - 9	P.C.	12 pt w 10 rt	TTF:	3016 HADH 345	MASSE, SES	11 PS 1	, 193 , 193	. ·	ned III
	0.467 0.467 0.467 0.467	0.600: 0.500: 0.500: 0.573:	0.375* 0.387* 0.382 0.381*	0.074: 0.064: 0.053: 0.042: 0.032:	0.000: 0.000: 0.000: 0.000: 0.000 1	0.000: 0.000: 0.000: 0.000:	0.073 0.344 0.170 0.134 0.282	1.073# 1.074# 1.357# 1.357# 1.255#	1.85.# 1.85.# 1.004# 1.802#	. 75 1 . 4.1 . 14.1	
-50000	3.556 3.527 3.513 3.531	0.500\$ 0.559\$ 0.552\$ 0.545\$ 0.539\$	0.350: 0.337: 0.327: 0.318: 0.308:	0.021 <b>*</b> 0.011 <b>*</b> 0.000 <b>*</b> 0.000 <b>*</b>	0.000\$ 0.000\$ 0.000\$ 0.000\$	0.000: 0.000: 0.000: 0.000:	0.340 0.003 0.000 0.000 0.438	1.843 1.840 1.850 1.854	1.000: 1.793: 1.794: 1.792:	.7431 \.730# \.730# 1.774# \.730#	.077# ********* 1 6/5# ******** 1.675# ******** 1.671# ******** 1.664 *********
	0.804 0.738 0.7378 0.7378	0.532* 0.525* 0.518* 0.511* 0.504*	0.2971 0.2061 0.2761 0.2651	0.000x 0.000x 0.000x 0.000x	0.000: 0.000: 0.000: 0.000: 0.000:	0.000: 0.000: 0.000: 0.000:	3.203 2 15.539 5.519 1.705	1.050x 1.050x 1.040x 1.040x 1.044x	1.790# 1.788# 1.784# 1.784# 1.782#	770: 720: 724: 724:	1.07 %
07.090 ***********************************	0.709* 0.702* 0.495* 0.633* 0.461*	0.490* 0.491* 0.404* 0.477* 0.470*	0.244# 0.233# 0.223# 0.212# G.202#	0.000x 0.000x 0.000x 0.000x	0.000% 0.000% 0.000% 0.000%	0.000:	1.903* 1.901* 1.099* 1.897* 1.895*	1.842* 1.840* 1.838* 1.834*	1.7808 1.7708 1.7768 1.7748 1.7728	7;08 7;08 7;48 1.7;48	(1.857)
1977 - 1977 1977 - 1977	0.875 <b>8</b> 0.660 <b>8</b> 0.661 <b>8</b> 0.654 <b>8</b> 0.647 <b>8</b>	0.4548 0.4578 0.4508 0.4438 0.4388	0.171: 0.180: 0.170: 0.157: 0.147:	0.000: 0.000: 0.000: 0.000:	0.000# (.000# 0.000# 0.000# 0.000#	0.000: 0.000: 0.000: 0.000:	1.093* 1.891* 1.089* 1.087*	:.07.: :.830: :.010: 026:	1.77.4 1.768 1.768 1.764 1.762	707: :705: 1703:	######################################
300000 30000 30000 30000	0.6418 0.6348 0.6278 0.6208 0.6138 0.6378	0.4301 0.4231 0.4161 0.4071 0.4021 0.000	0.138# 0.127# 0.117# 0.108# 0.095# 0.085#	2000.0 2000.0 2000.0 2000.0 2000.0	0.000 <b>:</b> 0.000 <b>:</b> 0.000 <b>:</b> 0.000 0.000	0.000 <b>1</b> 0.000 0.256 1.770 137 0.627	1.883* 1.881* 1.879* 1.877* 1.075* 0.000	1.8201 1.8201 1.8161 1.8161 1.6143 1.8178	1,7801 1.7581 1.7581 1.7541 1.7541 0.601	1 697 <b>8</b> 1.695 <b>8</b> 1.693 <b>8</b> 1.671 <b>8</b>	######################################
TOTAL MEAN MAX HIN AC-FT	19.774 0.630 0.736 6.513 39.021	25.032 0.501 0.400 0.402 29.015	7.553 0.744 0.396 0.035 14.901	0.297 0.019 0.074 0.009 0.509	0.000 0.000 0.000 0.000	3.793 0.122 1.770 0.000 7.523	01.705 2.774 23.283 0.000 (62.040	57.114 1.842 1.073 1.012	53.429 1.701 1.840 1.752 105.775	53,307 1,7,6 1,750 1,600 1,600	######################################

<sup>1)</sup> Recorder inoperable 2-6 through 3-21.

<sup>2)</sup> Weir washout occured 4-12, partial flow measurement only.

<sup>\*</sup> Interpolated value.

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# APPENDIX E

# PROPOSED AMD MITIGATION ALTERNATIVES

The MBMG proposed 5 alternative acid mine drainage treatment measures for field testing to the Montana Department of State Lands in March, 1983. A description of the theory and proposed tests of each alternative are contained in this appendix.

# E.1 State-of-the-Art in AMD Control

Lime and limestone treatment of acid mine drainage is a proven mitigation technique (Kim, et al., 1982; Bituminous Coal Research Institute, 1971; Hydrometrics, 1982). While lime  $(Ca(OH)_2)$  is more effective at neutralization per unit weight than limestone, several factors favor usage of limestone in crushed or pulverized form, including low cost per unit neutralization, local availability, fewer safety problems in handling a less reactive reagent, lower potential for harmful effects on the body of water receiving the effluent and denser sludge. Diebold (1975) found that one-inch crushed limestone fragments provided effective neutralization of iron and copper loads in Montana acid mine drainage at Hughesville, but not of manganese, zinc and cadmium. Even if centralized neutralization facilities are effective, they require significant capital and maintenance investments and are not easily adaptable to treatment of a number of polluting mines over a wide area without a sophisticated collection system, such as is the case at Sand Coulee. In addition, such facilities must be operated continuously, under a variety of discharge and climatic conditions.

Centralized lime neutralization facilities produce large quantities of amorphous sludge which present major handling and disposal problems. Large neutralization facilities are operated successfully, however, in areas where active mining is ongoing, and trained personnel and equipment are available. The lack of mining operations and dispersed nature of AMD sources in the Sand Coulee area are a major impediment to centralized neutralization.

Hydrometrics (1982) list 22 effluent treatment techniques for AMD control at Sand Coulee. They rule out all but three for various reasons: streamflow regulation, evaporation ponds and neutralization facilities. They list 17 mine manipulation techniques, three of which were designated as being potentially applicable: dam and flooding, hydraulic seals and seals using mine backfill. Eight hydrologic system control methods were listed, two of which were deemed potentially applicable: overburden water removal by wells and vegetative evapotranspiration.

Hydrometrics gave a qualitative rating of the potentially applicable methods to 10 acid discharges in the Stockett-Sand Coulee area. The highest rating of any technique was "fair", given to dam and flooding of the ASO4 adit (Brown Mine). Most ratings of success were poor, undetermined, no potential or variable. Overburden water removal methods were rated as poor for all sources, due to inadequate information on the aquifers involved and potentially large costs associated with well installation, maintenance, water pumping and piping. Evapotranspirational controls were rated poor or variable for various AMD sources, primarily due to insufficient information on recharge areas and no previous documentation of this technique for AMD control.

The U.S. Bureau of Mines (Kim, et al., 1982) has recently assessed the long-term success of various acid mine drainage treatments. Their recent inspections of wet, dry and hydraulic and/or bulkhead seals constructed over 10 years ago in West Virginia, revealed failures of 5 clay seals and continued discharge of acid water to a receiving stream. They indicated that mine sealing and flooding of 43,000 acres of old coal mines in Pennsylvania which are below the local drainage elevation, began over 30 years ago and that the water in some mine pools is now slightly alkaline. However, they state that in deep mines above the drainage elevation, "flooding is generally ineffective owing to seepage through fractures and the tendency of the water to migrate to other discharge points." The latter situation is the predominate case in the Stockett-Sand Coulee coal field.

The U.S. Bureau of Mines study briefly mentioned that overburden dewatering methods in the eastern U.S. have had limited success but are highly dependent on favorable hydrogeologic conditions. They made no reference to evapotranspirational control methods as a means of reducing infiltration to mines.

Results of this investigation generally support the findings of the previous studies. Mine sealing is one control technique which has been attempted in the Stockett vicinity. In one case, near the Giffen mine, sealing was performed successfully, but within a few months after sealing, a small seep had developed in the center of a nearby tract of agricultural land. Within a year, the seep had developed into a large marshy area discharging a flow reportedly not greatly different than that of the original spring. Because of the unpredictability of the effects of such sealing efforts, a number of local residents are

opposed to its use, as indicated by the results of the resident questionnaire carried out by Hydrometrics (1982).

## E.2 Infiltration Control by Intensive Cropping Methods

Planting of water-consumptive crops such as alfalfa, sanfoin and safflower and the use of continuous cropping rotations has been shown to be effective in limiting the amount of infiltration allowed to recharge shallow saline-seep ground-water systems (Miller et al., 1981). It is conceivable that application of such cropping practices could reduce infiltration to mine adits that cause acid discharge. Saline-seep research has demonstrated that alfalfa sends roots to depths of 15 feet or more, utilizing 18 in. of water annually, whereas cereal grains root to only several feet and utilize 7 to 8 in. of water annually. Recropping of cereal grains when soil moisture permits will almost double the evapotranspirational water use over the former 2-year crop-fallow system (Brown and Miller, 1978).

A drawback with this approach is that some of the recharge to ground water occurs in the late winter (during snowmelt) or during spring rains, when most crops are not consuming large amounts of water and when direct evaporation is minimal. The soils on the benches are thin and permeable, so that soil moisture may not be retained long enough for it to be consumed by crops in the summer months. However, in this area intensive cropping will decrease the volume of excess infiltration to some extent, even if it does not eliminate it entirely. Other infiltration control methods, such as draining of leaky upland stock ponds or ephemeral natural potholes, may reduce infiltration substantially and should be considered.

Efforts to reduce infiltration by intensifying agriculture, would have to be monitored via observation wells in the Kootenai aquifer and measurement of AMD discharge for a number of years after implementation, before the degree of their success could be evaluated. Full root development and water use by alfalfa, for example, does not occur until the third year after planting.

Acid discharge sources fed primarily by local recharge areas currently in a crop-fallow rotation are the best candidates for testing this infiltration control method. Such areas include the cultivated benches above ASO1, ASO2, ASO6, ASO7, CSO1 and CSO2.

Effective implementation of cropping system charges for control of dryland saline seep has been shown to require technical assistance to the farmers involved (Dodge et al., in press). Long term adoption of intensive farming practices in the study area must prove to be practical and economical if wholesale reliance on subsidies is to be avoided.

#### E.3 Horizontal Wells and Connector Wells

Installation and pumping of standard vertical wells to dewater the Kootenai aquifer, which is contributing leakage to abandoned mines, is a potential mitigation measure. However, the continued costs of pumping and maintenance appear to make this an undesirable and expensive alternative.

It is possible to take advantage of, or create, favorable differences in hydraulic head within wells, to gravity drain water from one aquifer to another or to the surface. The two well designs possible for use in dewatering the Kootenai aquifer are the connector

well and the horizontal well. The connector well would drain ground water from the basal Kootenai sandstone aquifer to the Madison group limestone which has a lower head, thereby preventing that water from draining into old mines and becoming acidized. The horizontal well would be drilled from a coulee into the basal Kootenai sandstone, just upgradient from old mine workings, and allow ground water to drain to the coulee before it leaks into the mines.

Connector wells have been used to dewater shallow aquifers in mining applications. A recent U.S. Geological Survey publication (Bush, 1983) describes the successful test of one connector well to recharge 50 gpm under gravity flow from a shallow sand aquifer to the underlying Floridan Limestone aquifer in central Florida. There is limited evidence to suggest that some domestic wells in the Stockett-Sand Coulee area may act as connector wells. A drillers log on a private well in T. 19 N., R. 4 E., sec. 23, indicates that ground water was encountered in the basal Kootenai sandstone, but that drilling continued 356 feet into the Madison limestone where a cavity was encountered. The total well depth was 586 feet, 71 feet below the cavity level and the well was uncased below 20 feet. The reported static water level was 515 feet below ground surface, just at the level at the bottom of the cavity. Ground water from the Kootenai aquifer may flow down the well bore to the level of the cavity in the Madison. instances of contaminated Madison wells mentioned in section 2.2.5.1 also illustrates the connector well principle. If applied to the AMD problem, the connector wells would inject fresh Kootenai water into the Madison group limestone.

Horizontal drainage wells have been most frequently used in

dewatering of mining headwalls and highway road cuts. In the Stockett-Sand Coulee area, horizontal wells could be drilled into the sides of coulees upgradient from existing AMD sources as a test of this technique. Their obvious advantage is the use of gravity drainage and the elimination of long-term pumpage requirements. Secondarily, the water removed through drainage would be typical alkaline Kootenai water and with a minimum of conveyance would be available for dilution of other AMD water in the receiving stream.

Favorable sites for horizontal well tests include several acid springs and mine discharges near Sand Coulee such as ASO1, ASO4, ASO9, CSO1 and CSO2. The configurations of these coulees and predominantly local recharge sources create apparently favorable conditions for intercepting a sizeable portion of the ground-water flow field reaching the old mine workings.

The drilling distances would be variable, depending on the test site chosen and the quantities of water intercepted as the drilling progresses. It is estimated that a 500-1000 ft. hole would be attempted initially. The yield of a horizontal drainage well in the basal Kootenai sandstone is problematical, very much dependent on the quantity of saturated fractures encountered.

Vertical test wells would be drilled on the benches above these adits to the Morrison coal bed along the projected axis of the horizontal well. This will help confirm the extent of the old mine workings and provide elevation control on the basal Kootenai sandstone prior to drilling the horizontal wells.

The effectiveness of the horizontal wells in AMD control would be determined by measuring the discharge from the two adits with flumes or

weirs fitted with continuous recorders, both before and after operation of the drainage wells. The drainage well discharge would be measured continuously with recording flowmeters or flumes. Both adit and drainage well disharge would be sampled for water quality analyses during the flow tests.

### E.4 Subsurface Injection of AMD

A potential AMD disposal and neutralization method may be gravity injection into the Madison limestone. The effectiveness and impacts of injection could be assessed with controlled field tests. The objectives of the tests would be to determine the effectiveness of AMD neutralization, porosity--permeability changes due to injection, extent of metal precipitation, and water quality impacts of AMD injection on the Madison aquifer.

Acid mine drainage leakage into the Madison aquifer is already occurring throughout the Stockett-Sand Coulee area in an uncontrolled fashion. There are several cases of Madison ground-water contamination reported by landowners and at least four additional suspected cases based on MBMG water quality data. AMD disharge in Sand Coulee, Number Five Coulee, Cottonwood Creek and Straight Creek is known to be lost to subsurface seepage, contaminating alluvial ground waters and probably the Madison as well. The results of controlled AMD injection tests would indicate whether such a procedure is preferable to uncontrolled leakage to several aquifers along the entire drainage network.

However, there is reason to question the applicability of such an injection program. As acid mine water is discharged into partially saturated zones of cavernous porosity in the Madison, several processes

will take place concurrently. If undiluted acid water comes in direct contact with limestone in the unsaturated portion of the Madison, it will tend to dissolve carbonates and may enhance porosity. As the pH rises above 4.5, both iron and aluminum will rapidly precipitate from solution as insoluble, amorphous hydroxides. As it reaches the saturated portion of the Madison, it may have little or no remaining acidity; what acidity remains will be buffered by the alkalinity of the Madison water, causing complete precipitation of the metal load down to the solubility of controlling metal hydroxide or carbonate species.

The major obstacle to the successful operation of such an injection well system would probably be the ability of the aquifer and well to resist becoming clogged with metal hydroxide precipitation products. Mines in the Sand Coulee area, those of poorest quality in the region, typically range from 600-1600 mg/L total dissolved metals, primarily iron and aluminum with much lesser quantities (<50 mg/L Zn, <10 mg/L Ni, Cu, Mo) of other metals. Assuming an average annual discharge of 40 gpm (2.5 liters per second (1/s)) for a hypothetical spring of typical water quality and metal load (TDS = 5000 mg/L; metals = 1.1 grams/L), and assuming a mean density of 3.0 g/cc for the metal precipitate (gibbsite - 2.4; ferric hydroxide - 3.3-4.3, depending on hydration), a total volume of 1024 ft<sup>3</sup>/year will precipitate from solution in the subsurface if the total discharge were to be injected into the Madison. Assuming a void ratio of 100 percent in this precipitate, approximately 1766 ft 3/year would precipitate from injection water of just one spring. Such volumes could potentially clog even a large zone of cavernous porosity in the Madison over the period of a few years.

However, there are some factors which would support the feasibil-

ity of injection. First of all, the water would most likely be injected into the upper Madison which is partially unsaturated, and before it reaches the water table it may dissolve a significant volume of carbonates due to the water's high acidity, enhancing porosity and permeability. Secondly, our results indicate that acid streamflow is probably currently leaking into the underlying Madison in the Sand Coulee-Stockett area. Therefore, the injection concept may prove practical, provided that zones of cavernous porosity are present in the Madison to accommodate the anticipated metal load.

Certainly, however, the water quality impacts of such injection would have to be predicted and evaluated. Acid water injected into the aquifer would become neutralized with respect to metals and acidity. The Madison aquifer may, however, be degraded by the higher sulfate levels (2000-8000 mg/L) in the acid water, or by an increase in  ${\rm Ca}^{2+}$  and  ${\rm Mg}^{2+}$  concentrations due to carbonate and dolomite dissolution.

Many Stockett-Sand Coulee residents have abandoned alluvial wells for deeper Madison aquifer wells. Any acid water injection proposal would have to be sanctioned by residents and carefully monitored to determine overall impacts. We have proposed one possible approach to conducting controlled field tests and evaluation of the injection technique.

Initial well drilling, logging and testing would be conducted to locate a favorable site. The vertical gradient must be downward, and there should be some initial solution or cavernous permeability in the upper unsaturated Madison group limestone.

An initial 10-day injection test would be run. Following a favorable evaluation of the first test, a second 100-day test would be

conducted. Water quality analyses of the observation wells, injection well and mine discharge would be made three or more times throughout the tests. Field pH, S.C. and alkalinity measurements would be made frequently. Continuous water level data would be collected throughout the test periods. The nearest private Madison well would be sampled before and after the test periods.

Following the tests, geophysical logs would be run again on the injection well and observation well changes in porosity and permeability caused by metal hydroxide deposition and carbonate dissolution. Aquifer pumping tests or slug tests would be re-run to determine permeability changes. Two new wells would be drilled to determine the extent of metal deposition and obtain samples.

The results of field sampling would be used as input to hydrochemical modeling of the injection test. Analytical calculations and computer modeling would be employed to estimate the mechanisms and rate of acid neutralization and metal precipitation over time. The extent of porosity, permeability and water quality effects on the Madison aquifer would be evaluated. Recommendations regarding the long-term hydrogeologic feasibility and impacts of AMD injection to the Madison Group rocks would be made.

# E.5 Flyash Neutralization

Flyash residue from coal-fired electric power plants is rich in calcium and has been tested and found to be effective in neutralizing pyrite induced acidity. Sonderegger and Donovan (1982) conducted acid titration and batch leach laboratory experiments with various mixtures of flyash and pyrite mine tailings and found that flyash has both

short-term and long-term buffering capacity. A one to ten, flyash to tailings mixture, was estimated to maintain a buffering capacity exceeding 100 years. Iron mobility in column leach tests with flyash was reduced by up to three orders of magnitude.

It is believed that small volumes of acid mine drainage water could be effectively neutralized by short-term retention and mixing with flyash in a small pit. An investigation would be needed to test the effectiveness and maintenance requirements of small flyash pits as a means to neutralize the numerous small acid water discharges in the Stockett-Sand Coulee area.

Pits of about 200 ft<sup>3</sup> in size would be excavated and filled with flyash. Acid inflows would be injected through the bottom of pits, where neutralization occurs prior to being discharged from the top of the downstream side of the pit. Water quality sampling and field testing of pH, S.C. and alkalinity of inflows and outflows would be done to document the rate of neutralization, bulk neturalization capacity of the flyash in the pit and affects on overall water chemistry and metals concentrations. The pit would be profiled afterwards, and maintenance and operation feasibility assessed.

### E.6 Kootenai Water Neutralization

A simple and possibly effective AMD neutralization technique would be to mix alkaline ground water from the Kootenai aquifer with small volumes of acid mine drainage water. The mixing would occur in a pit where metals would be allowed to precipitate prior to discharge of the effluent.

Typical ground water from the lower Kootenai formation has an

alkalinity of 200 to 350 mg/l as  $CaCO_3$ . Assuming a mix of 2500 mg/l (as  $CaCO_3$ ) acid mine water, a 10:1 volumetric ratio of Kootenai to AMD water is required theoretically to achieve neutralization.

A several month test would be conducted to evaluate the effectiveness and field procedures associated with utilization of Kootenai ground water in neutralizing acid mine drainage in the Sand Coulee area.

Water quality samples and field pH, S.C. and alkalinity data would be collected at inflows and outflows to document the effectiveness of the technique.

The flyash and Kootenai ground-water neutralization experiments would be conducted with the purpose of determining the minimal field installation required for non-mechanical but effective treatment of the numerous small and ephemeral acid seeps in the study area. Such an alternative could be adopted by individual residents at low cost to assist regional AMD clean up efforts.

## E.7 Treatments in Combination

There will probably never be a single mitigation technique feasible for controlling all acid mine drainages. Once implementation and testing of the previously discussed techniques on an individual basis is completed, various combinations may enhance AMD control.

If the head and permeability characteristics of the basal Kootenai sandstone aquifer prove conducive for horizontal wells, this technique could be combined with mine flooding and bulkheading. The two treatments could complement each other. The horizontal well will provide a hydraulic pressure release mechanism, maintaining hydrodynamic equilib-

rium and helping prevent unplanned seepage. The flooding will slow acid producing reactions in the old mines and may increase head in the overlying sandstone, thereby improving yields from the horizontal well at the expense of mine flow. The discharge of alkaline ground water from a horizontal well may provide an opportunity to neutralize the remaining acid flow in a pit below the source as indicated in the previous section.

Reductions in acid mine baseflows and total volume from intensive farming methods in recharge areas may allow installation of retention ponds or neturalization pits (using flyash or limestone) to treat the remaining acid flow. Mine flooding and bulkheading could be combined with injection of surplus water to a deeper receiving zone such as the Madison group limestone. A closed system overflow pipe could siphon surplus mine pool water in a relatively unoxygenated state to a deeper receiving aquifer. If acid-forming reactions could be minimized in the mine and rapid injection of ground-water recharge slugs accomplished, the injection water may be of better quality than typical AMD water. Mine pool water injected in this manner may result in water quality impacts to the Madison aquifer less than those currently being experienced.